USER'S MANUAL

FOR THE

BRANSON/IPC 2000 SERIES

PLASMA SYSTEM

Part No. A10488 Rev. A

5/26/83

1.0 INTRODUCTION

1.1 Description

The IPC S2000 Series Plasma System generates a low pressure, low temperature gaseous plasma. The machine comprises a source of electrical power; means for coupling this power into the plasma treatment chamber(s); and a system to control the flow of reactant plasma gases.

The system is a fully automatic processing machine which has three modes of operation: Automatic, Semi-automatic and Manual.

All flow controls and power controls are electrically operated through switches and relays..

2.0 EQUIPMENT SUPPLIED

2.1 Listing:

The equipment supplied comprises one each of the following:

R. F. GENERATOR

PROCESS CONTROLLER

REACTOR CENTER

VACUUM PUMP (Optional)

2.2 Unpacking:

All parts and components should be carefully removed from their shipping containers and examined for possible damage during shipment. Any damage should be reported immediately to your carrier.

Inspect the glass components for possible shipping damage.

2.3 Equipment Supplied:

The following equipment is supplied to:

AT+T TECHNOLOGY

Under P. O. Number 140874

Model Number: IPC 52005-11020, comprising:

PM 119 R. F. Generator (Serial No. 10003097)

PM 11020 Reactor Center (Serial No. M90810-1)

PM 2000C Controller (Serial No. 10003592)

Cables as follows:

1 P/N 1163-002 — 1 Plug P/N 04340

1 P/N 2349-005 — 4 Cap. P/N 5970-0026

1 P/N 2351-001

1 P/N 10483

1 P/N 2973-002 (Temp Option)

1 P/N 6548-001

4 P/N 03579 (Capacitance Manometer Option)

Instruction Manual P/N _____

Vacuum Pump (Serial No. _____

3.0 INSTALLATION

3.1 General Instructions:

After the IPC S2000 Series System and components have been removed from their packages the machine is ready for set up. Gas lines and electrical cables may be connected.

The meters have been shorted to prevent electrical damage during shipment. BE SURE TO REMOVE SHORTING WIRES BEFORE SYSTEM OPERATION.

3.2 Vacuum Pump Installation:

The vacuum pump is supplied with its own isntallation instructions. These should be referred to for installation of pump, oil and attachment of power cord.

The exhaust manifold extension protrudes from the hole in the rear of the Reactor Center chassis. The flexible hose provided is coupled directly from the exhaust manifold extension to the nipple supplied with the vacuum forepump.

4.0 INITIAL OPERATION AND CHECKOUT

4.1 Front Panel Controls:

(1)	READOUT CLOCK:	Reads out time to a 10th of a minute. Maximum readout is 99.9 minutes.
(2) (3)	THUMBWHEEL SWITCH:	Pre-selects process time for each program. Maximum time is 99.9 minutes.
(3)	AC ON/OFF SWITCH:	Turns on and off AC power to system.
(4)	VACUUM SWITCH & INDICATOR:	When indicator light is "ON" vacuum solenoid is open, allowing vacuum to be drawn.
(5)	PURGE SWITCH & INDICATOR:	When light is "ON" purge solenoid is open to the atmosphere.
(6)	MANUAL/AUTO MODE SWITCH	In AUTO position the system can be operated in automatic or semi-automatic mode.
(7)	(a) FLOW SWITCH, (b) INDICATOR & (c) FLOW ADJUST VALVE:	(Three Programs) When light is "ON", flow solenoid for that program is open. Flow can be adjusted with needle valve.

(8)	(a) POWER SWITCH, (b) INDICATOR & (c) POWER ADJUST CONTROL:	When the light is "ON" the power level can be adjusted by means of the power knob and observing the wattmeter.
(9)	FORWARD/REFLECTED POWER SWITCH:	With switch in FORWARD postion the forward power can be monitored on the upper scale of the wattmeter. With switch in REFL. position reflected power can be monitored on lower scale.
(10)	TORRMETER:	This indicates vacuum in torr (mm of mercury).
(11)	POWER METER:	Indicates power in watts.
(12)	RESET LIGHT:	Indicates end of sequence automatic mode.
(13)	START PUSHBUTTON:	Starts sequence for automatic mode, i.e., the three pumpdowns, the three programs and the end of process alarm and light (over reset pushbutton).
(14)	CYCLE PUSHBUTTON:	Every consecutive push of this pushbutton steps the processor to the next state. The clock will not start at this time but can be started by selecting the desired program with the cycle switch and pushing the start switch to start the clock. The processor is then in automatic mode.
(15)	RESET PUSHBUTTON:	This resets the clock to 000 and the program control. The vacuum solenoid is closed and the purge valve is opened. Samples can be placed into or removed from the reactors.

(16) TIME/BYPASS/TEMP SWITCH (Program 1): This three position toggle switch determines the method of controlling the period of Program 1.

In the center position (BYPASS) the programmer steps through Program 1 (eliminating the need for setting the thumbwheel switches to zero).

In the TIME position the period of Program 1 is determined by the setting of Program 1 thumbwheel switches.

In the TEMP position the period of Program 1 is determined by the Temperature Controller. The Temperature Controller module is optional. If the system does not include a Temperature Controller, the programmer will bypass Program 1 when the switch is in the TEMP position.

(17) TIME/BYPASS SWITCH (Program 2): This position toggle switch causes the programmer to step through Program 2 in the BYPASS position. In the TIME position the period of Program 2 is determined by the setting of the Program 2 thumbwheel switches.

(18) TIME/BYPASS/DET SWITCH (Program 3): This three position toggle switch determines the method of controlling the period of Program 3.

In the BYPASS position the programmer steps through Program 3.

In the TIME position the period of Program 3 is determined by the setting of the Program 3 thumbwheel switches.

In the DET position the period of Program 3 is determined by the optional DPS 2300 END OF PROCESS DETECTOR. If no DPS 2300 is provided with the system, the programmer will bypass Program 3 when the switch is in the DET position.

NOTE: START, CYCLE AND RESET PUSHBUTTONS are used only in automatic and semi-automatic modes of operation. They do not function in the manual mode.

4.2 Installing the Gas Lines:

Several options are available for installing the reactant gases. The S2000 Series System may be set up to run one gas at three different RF power levels and flows; alternately the machine may be set up to run a different gas in each channel.

Connect the gas(es) to the desired Program with 1/4" plastic or metal tubing. Swagelock connectors for the gas lines are found on the back panel of the Control Module. There are four such connections on the back panel: one for each Program and one for a purging gas (if desired). Insure that all connections are tight. NOTE: Input gas pressure should not exceed 5 PSIG.

The tormeter may be calibrated for other gases by using the appropriate conversion factors (refer to figure 1). In general, the plasma process, such as etching SnO_2 and removal from KFMR photoresist, require specific pressures. However, flowrators are provided with the system for monitoring flows.

!CAUTION!

THIS EQUIPMENT HAS BEEN DESIGNED FOR USE WITH THE FOLLOWING GASES:

ARGON	HELIUM
NITROGEN	AIR
OXYGEN	CF_4/O_2

USE OF ANY GASES OTHER THAN THOSE LISTED ABOVE MAY BE HAZARDOUS. DO NOT USE OTHER PROCESS GASES WITHOUT PRIOR WRITTEN APPROVAL OF BRANSON/IPC, 31172 HUNTWOOD AVENUE, HAYWARD, CALIFORNIA 94544.

4.3 Initial Operation:

After making initial electrical connection, insure the following:

ON/OFF switch on the generator is OFF.

AC ON/OFF switch on the Process Programmer is OFF.

ON/BYPASS switch in UP position.

The Vacuum switch is in AUTO (down) position.

The Purge switch is in AUTO (down) position.

The MANUAL/AUTO switch is in MANUAL position.

4.3 (continued)

Initial switch position before external AC electrial power is applied: RF GENERATOR ON/OFF SWITCH IS OFF!!

Flow adjust switches on Program 1, 2, and 3 will be in AUTO (down) position.

!CAUTION!
DO NOT ATTEMPT TO TURN OFF THE GAS FLOW COMPLETELY WITH THE FLOW ADJUST NEEDLE VALVES (OFF CLOCKWISE), AS FORCING THE NEEDLE AGAINST THE SEAT MAY PERMANENTLY DAMAGE THE VALVE.

RF power control knobs will be completely counter-clockwise.

RF switches in AUTO (down) position.

FORWARD/REFLECTED switch will be in FORWARD position.

AC power is now ready to be applied:

(1) Plug the AC cable on the RF generator to a nominal 115V or 220V power source as specified in generator manual.

(2) Turn the AC power switch on the generator to the ON position. The AC indicator will illuminate. After a delay of about three minutes the READY lamp will light signifying generator is ready to supply RF power.

(3) Turn AC ON/OFF switch on the Process Controller to ON. The AC power indicator should light and the LED display indicate 000.

4.4 Initiating a Plasma:*

Before attempting to initiate a plasma be sure that the READY light on the front panel of the generator is ON, all cooling fans are operating and that the vacuum pump is turned ON. Program 1 flow and RF controls may be used to initiate the first plasma.

(1) Raise the Purge switch. The Purge indicator should light and the pressure in the Reactors comes to atmosphere. This is indicated on the torrmeter on the Process Controller.

4.4 (continued)

(2) If the Reactor door(s) are already open, close them now. They should both open and close easily at the atmospheric pressure attained in the Purge state.

(3) Lower the Purge switch to AUTO and raise the Vacuum switch. The Reactor door(s) should pull tightly against the Reactor front surface and the system pressure commence to drop. After less than a minute of pumping the pressure on the torrmeter should be less than 0.5 torr. When the system is first pumped down this time may be lengthened by absorbed water on the Reactor walls.

It may be noted that the torrmeter indicates less than zero on the meter. This is of no consequence since readings at this low pressure are unreliable. The gauge has been calibrated to read correctly over the pressure range 0.5 - 5.0 torr and the zero point has been allowed to fall where it may.

(4) Raise the RF power switch for Program 1.

!CAUTION!
DO NOT TURN ON R. F. POWER UNTIL CHAMBER PRESSURE GOES BELOW 5 TORR OR SERIOUS DAMAGE TO THE SYSTEM MAY RESULT.

(5) Raise the RF level control for Program 1 in the clockwise direction.. At this low pressure in he Reactor a plasma should initiate at very low power. Turn the RF control to about mid-position.

(6) Raise the flow switch for Program 1.

(7) Open the flow adjust valve for Program 1 until the torrmeter indicates a pressure rise. Set the flow to the desired operating pressure with O_2.

(8) It should be possible to set the RF power control knob fully clockwise and raise the flow until the torrmeter indicates a pressure of 4.0 - 5.0 torr. It may be noted that lowering the RF power control will reduce the forward power, but the reflected power will rise at the same time until eventually they become equal and the plasma extinguishes.

If raising the power control does not re-initiate the plasma, turn off the flow switch until the pressure drops to a point where the plasma does initiate. The switch may then be turned on again to bring the flow back to its original value.

4.4 (continued)

(9) The IPC S2000 Series System has an impedance matching network which has been designed to operate over a wide range of pressures (0.5 - 5.0 torr) and power levels from 0 to maximum. This system includes an Automatch and these functions are fully automatic without operator intervention.

5.0 MODES OF OPERATION

5.1 Manual Operation:

In manual operation all flow solenoids and power controls are turned on or off by means of a switch. Position vacuum switch to the MANUAL (Up) position and Purge switch to the AUTO (down) position, and the MANUAL/AUTO switch to MANUAL. This will allow a vacuum to be drawn.

5.2 Semi-Automatic Operation:

(1) AC power off.

(2) Vacuum switch in AUTO (down) position.

(3) Purge switch in AUTO (down) position.

(4) Manual/Auto switch in MANUAL (up) position.

(5) All flow and RF power switches will be in AUTO (down) position.

(6) All Program Bypass switches in the up position.

(7) All power controls will be counter-clockwise.

(8) Turn AC On/Off switch to ON.

(9) The AC power indicator light should light and the indicator should read 000.

(10) Manual/Auto switch to AUTO. Purge indicator should light, and the system pressure should rise to atmosphere.

(11) Depress the Cycle button. At this time the Purge light should go out and the Vacuum light should be illuminated. This allows a vacuum to be drawn.

(12) When the Torrmeter is less than 0.1 torr, depress the Cycle button again and the RF and Flow indicator lights for Program 1 should be illuminated.

Each time the Cycle switch is depressed the system switches to pumpdown cycle and, on the next depression, to the following cycle.

After Program 3 light has been illuminated the next push of the Cycle button will turn on the audible signal and the END OF PROCESS light above Reset button should illuminate.

(13) Push the Reset button to turn off the audible signal and the Reactor(s) will purge to atmosphere.

Run through this procedure a few times to be sure the operation is repeatable. This procedure has shown us that the semi-automatic mode is working properly.

5.3 Automatic Operation:

(1) AC/On/Off Switch on Process Programmer is OFF.

(2) Vacuum, Purge, and Power switches are in AUTO position.

(3) Manual/Auto switch is in MANUAL (Up) position.

(4) RF Power controls are in complete counter-clockwise position.

NOTE: To start the automatic operation the program thumbwheels will be pre-adjusted to a specific time. The time is adjustable to 1/10 of a minute, i.e., a time of 00.1 to 99.9 minutes can be programmed.

(5) Turn the AC On/Off switch on the Process Programmer to ON.

(6) The AC Power indicator light should illuminate and the clock read 000.

(7) Turn the Manual/Auto switch to AUTO (down) position.

(8) Depress START button. At this time the vacuum indicator light shoiuld illuminate and the readout should start counting.

5.3.1 Program 1:

At the end of the pumpdown the clock will reset to "0", Program 1 will start and its RF and Flow lamps will illuminate.

5.3.2. Pumpdown:

As soon as the preset time of Program 1 is reached the process will end and the system will go into the second pumpdown cycle to remove the gas remaining in the Reactor Chamber(s).

5.3.3 Program 2:

After the second pumpdown the system will step to Program 2, resetting the clock to 000 and going up to the time preset for Program 2.

5.3.4 Pumpdown:

The system pumps down again after Program 2 is finished.

5.3.5 Program 3:

After the third pumpdown Program 3 commences and continues until the end of time preset for Program 3.

5.3.6 Audible signal will sound to indicate end of process and the End-Of-Process indicator will illuminate.

5.3.7 Depress Reset button to purge the Reactor(s) back to atmosphere.

5.4 Pre-Programming the System for Automatic operation:

(1) Be sure that all vacuum lines and electrical cables are connected properly.

(2) R. F. Generator power OFF.

(3) Process Programmer AC Power Off.

(4) Manual/Auto switch on MANUAL.

(5) Vacuum switch will be in MANUAL position.

(6) Purge switch will be in AUTO position.

(7) Turn AC Power on R. F. Generator ON.

(8) AC Power on Process Programmer ON.

At this time pumpdown should begin. When Torrmeter reads 0.1 torr or less, programs may be pre-set.

5.5 Pre-setting Each Program:

(1) Turn desired Flow switch to MANUAL (Up) position.

(2) Observing the Torrmeter, adjust flow to the desired amount, using flow adjust valve for that Program.

(3) Turn off Flow switch and let the pressure drop below 0.1 Torr.

(4) With the Forward/Reflected switch in a FORWARD position turn the RF Power switch for the desired Program to the MANUAL (Up) position and slowly turn the power knob in a clockwise position to the desired power level.

A plasma discharge should be observed at this time in the Reactor Chamber. After the plasma is initiated turn the Flow switch back on. Set the power to the desired level.

(5) Turn Forward/Reflected switch to REFLECTED and be sure that the reflected power is less than 15 watts.

(6) Turn OFF Program Flow and RF Power switches.

This procedure has adjusted the RF Power and Flow to a pre-determined level. Other programs are adjusted in the same manner, adjusting the Flow first, and then adjusting the RF Power control.

Flow and RF Power are now programmed; only the time on the thumbwheels needs to be set to each desired process time.

If at any time it is desired to eliminate one or two of the Programs, move the corresponding Program Bypass switch to the bypass position.

5.6 Final Check Before Automatic Operation:

Before going to a completely automatic mode of operation a semi-automatic check of power and flow can be made easily.

5.6.1 This is done by placing the Vacuum and Purge switch on the Process Programmer in an AUTO (down) position and the Manual/Auto switch to the AUTO (down) position.

5.6.2 Be sure that all of the Flow and RF switches on the Control Module are in the AUTO position and the Forward/Reflected power is in the FORWARD position.

5.6.3 Push the Reset button on the Process Programmer. Only the Purge light should be illuminated at this time. Depress the Cycle switch once and the Purge light should go out and the Vacuum light should illuminate.

5.6.4 At the same time the Vacuum meter should be observed and go down to less than 0.1 torr. As soon as this vacuum is achieved, depress the Cycle switch again. At this time Program 1 RF and Flow lights should illuminate. Observe the torrmeter and wattmeter to insure that the initial Program is correct. A plasma discharge will be observed.

5.6.5 Depress the Cycle switch. The RF and Flow lights of Program 1 should go out and the System pump down.

5.6.6 When the pressure is below 0.1 torr press the Cycle switch. Program 2 lights should come on. Preset pressure and power should be observed.

5.6.7 Depress the Cycle switch. The RF and Flow lights for Program 2 should go out and the System should pump down.

5.6.8 When the pressure is below 0.1 torr press the Cycle switch. Program 3 lights should come on. Preset pressure and power should be observed.

5.6.9 Depress Reset button. The Vacuum light should go out and the Purge light should again come on. The Processor is now ready for completely automatic processing.

6.0 PROCESS CONTROLLER - THEORY OF OPERATION

6.1 The sequencing of the S2000 System automatically through the steps described above is controlled by the Process Controller. For each of explanation we shall refer to the various phases of the process as States. There are eight as follows:

0 Pumpdown preceding Program 1.
1 Program 1.
2 Pumpdown preceding Program 2.
3 Program 2.
4 Pumpdown preceding Program 3.
5 Program 3.
6 End of Process. Audible and visual signal.
7 Purge.

For a functional description of the Programmer refer to the block diagram of Figure 1. The system is digital and is comprised of TTL integrated circuits. As mentioned previously, the system proceeds through its steps at intervals of 0.1 second. The 10/sec. signal required is produced by the CLOCK GENERATOR, which also generates the basic system clock of 60 Hz. The display of the elapsed time for each phase is the function of the COUNTER AND DISPLAY. It also produced signals at intervals of 1 minute (1/min) and .10 minutes (.1/min).

The time period for each of the states of the programmer is determined by:

a) Setting of the front panel thumbwheel switches for each of the three programs.
b) Internally wired options for each of the pumpdown periods.

The ten position thumbwheel switches and the busses interconnecting them are indicated by the MATRIX shown in the block diagram (Fig. 1.) The Programmer then functions by virtue of three sequencers or scanners.

The PROGRAM SEQUENCER provides the eight process states itemized above with an output for each state. Each of these outputs effects the operation of the appropriate gas valves and relays comprising the TRIACS and LIGHTS. The PROGRAM SEQUENCER increments in order from one state to the next under control of the second of the sequencers, the COMMUTATOR.

The COMMUTATOR scans in a fixed order the positions of the twelve "switches" (hard wire and thumbwheel) comprising the MATRIX. The ADDRESS GENERATOR controls the scanning sequence of the COMMUTATOR. The period of time that the COMMUTATOR dwells on each of its twelve inputs is determined by the setting of each switch and the DIGIT SEQUENCER.

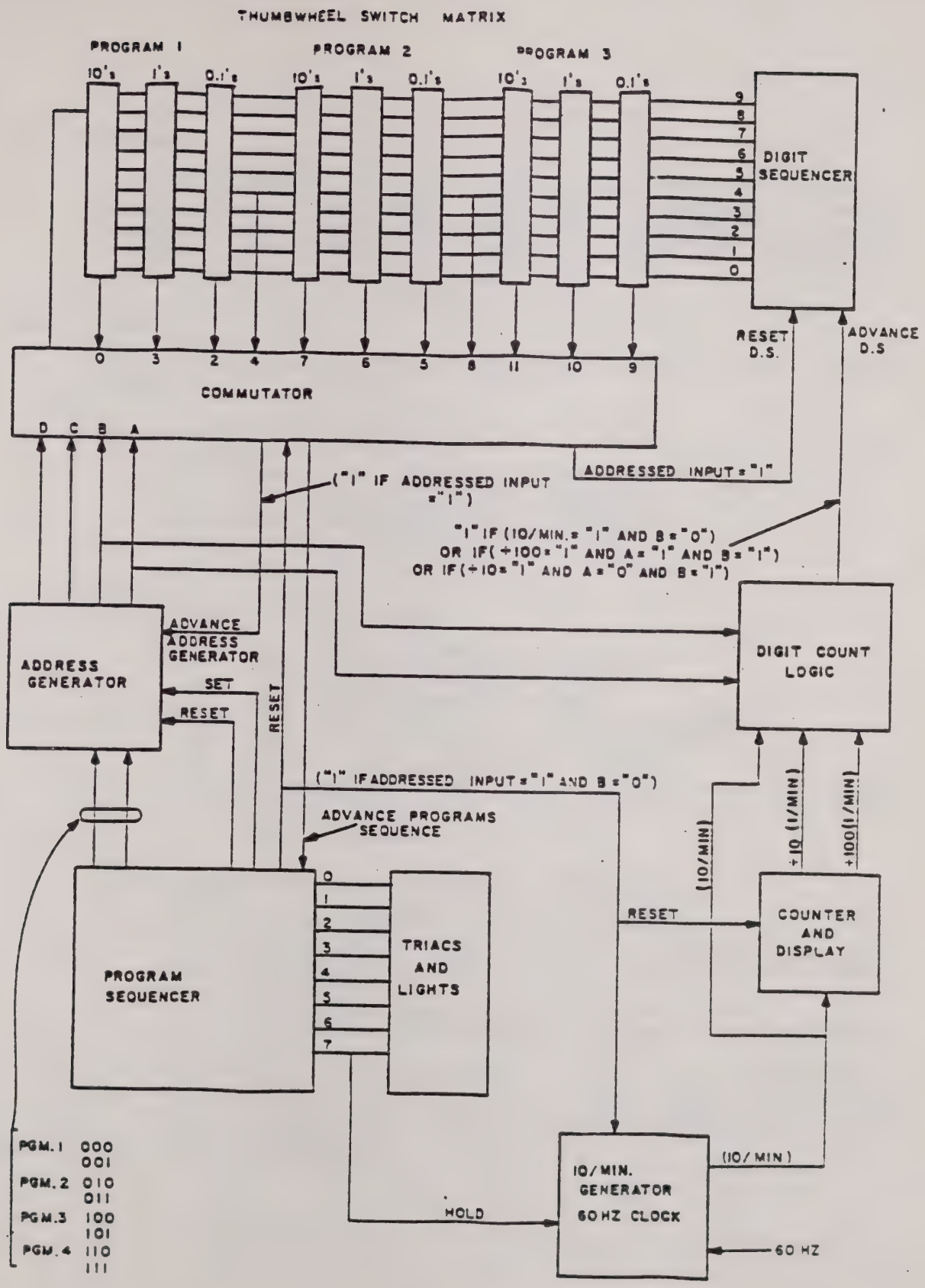

THUMBWHEEL SWITCH MATRIX
PROGRAM 1
PROGRAM 2
PROGRAM 3
10's
1's
0.1's
DIGIT SEQUENCER
COMMUTATOR
RESET D.S.
ADVANCE D.S
ADDRESSED INPUT = "1"
("1" IF ADDRESSED INPUT = "1")
"1" IF (10/MIN. = "1" AND B = "0")
OR IF(÷100 = "1" AND A = "1" AND B = "1")
OR IF(÷10 = "1" AND A = "0" AND B = "1")
ADDRESS GENERATOR
ADVANCE ADDRESS GENERATOR
SET
RESET
DIGIT COUNT LOGIC
("1" IF ADDRESSED INPUT = "1" AND B = "0")
ADVANCE PROGRAMS SEQUENCE
PROGRAM SEQUENCER
TRIACS AND LIGHTS
(10/MIN)
+10 (1/MIN)
+100(1/MIN)
COUNTER AND DISPLAY
PGM.1 000 001
PGM.2 010 011
PGM.3 100 101
PGM.4 110 111
HOLD
10/MIN. GENERATOR 60 HZ CLOCK
(10/MIN)
60 HZ

FIG. 1

6.1 (Continued)

The DIGIT SEQUENCER is a "shift register" which energizes in sequence the ten busses of the MATRIX. The interval at which it increments depends upon which switch the COMMUTATOR is scanning (e.g., 10 minute interval if the COMMUTATOR is scanner one of the 10's thumbwheels) and is controlled by the DIGIT COUNT.

6.2 Logic:

The orderly sequence of events is then as outlined in the following table:

6.2.1 Depress "Reset" Button:

(1) Sets PROGRAM SEQUENCER to State "7".
(2) Sets ADDRESS GENERATOR to "1100" (12).
(3) Sets DIGIT SEQUENCER to "1000000000".
(4) Sets COUNTER AND DISPLAY to "000".
(5) Sets 10/min GENERATOR to "0" and "hold".

6.2.2 Depress "Start" Button:

(1) Sets PROGRAM SEQUENCER to state "0".
(2) Removes "hold" from 10/min GENERATOR
(3) Sets ADDRESS GENERATOR TO "0000".
(4) DIGIT COUNT LOGIC gates through 10/min signal.
(5) 10/min signal advances COUNTER AND DISPLAY.
(6) 10/min signal advances DIGIT SEQUENCER.
(7) DIGIT SEQUENCER (and COUNTER) advances with each 10/min signal until logic "1" appears at "0" input of COMMUTATOR, then:

6.2.3 Logic "1" Appears at Outputs of COMMUTATOR:

(1) PROGRAM SEQUENCER advances to state "1".
(2) ADDRESS GENERATOR advances to "0011" (3).
(3) COUNTER AND DISPLAY, 10/min GENERATOR, and DIGIT SEQUENCER reset.
(4) DIGIT COUNT LOGIC gates ":100" signal (.1/min).
(5) COUNTER AND DISPLAY proceeds to advance with each 10/min signal.
(6) DIGIT SEQUENCER advances with each .1/min signal until logic "1" appears at "3" (0011) input of COMMUTATOR (determined by the setting of Program 1 - 10's thumbwheel).

6.2.4 Logic 1" Appears at Outputs of COMMUTATOR:

(1) ADDRESS GENERATOR advances to "0010" (2).
(2) DIGIT SEQUENCER resets.
(3) DIGIT COUNT LOGIC gates ":10"in signal (1/min).
(4) COUNTER AND DISPLAY continues to advance with each 10/min signal.
(5) DIGIT SEQUENCER advances with each 1/min signal until lgoic "1" appears at "2" (0010) input of COMMUTATOR (determined by setting of Program 1 - 1's thumbwheel).

6.2.5 Logic "1" Appears at Outputs of COMMUTATOR:

(1) ADDRESS GENERATOR advances to "0001" (1).
(2) DIGIT SEQUENCER resets.
(3) DIGIT COUNT LOGIC gates 10/min signal.
(4) COUNTER AND DISPLAY continues to advance with each 10/min signal.
(5) DIGIT SEQUENCER advances with each 1/min signal until logic "1" appears at "1" (001) input of COMMUTATOR (determined by setting of Program 1 - .1's thumbwheel).

6.2.6 Logic "1" Appears at Outputs of COMMUTATOR PROGRAM SEQUENCER advances to state "2":

(1) Sequence of events described in subsection 6.2.3 repeat for each state through state "6". At this time depressing the "reset" button cycles PROGRAM SEQUENCER to state "7" described in 6.2.1.

6.3 Circuit Description:

The circuitry of the 906 is package on three printed circuit boards as follows:

(1) Mother Board
(2) Thumbwheel Board
(3) Display Board

These boards are shown schematically on drawing #D03208. This schematic is included at the end of this section, within this manual. For convenience the portion the schematic pertinent to each of the functional blocks previously described is shown separately here.

6.3.1 Commutator:

The COMMUTATOR, Figure 2, consists of a DATA SELECTOR MULTIPLEXER, SN74150, and appropriate gating. The output (w) of the multiplexer is low (zero volts) when the data input selected by the binary coded ABCD inputs is high. Otherwise the output is high. The signal ADVANCE PROGRAM SEQUENCE is therefore low when B is low and there is coincidence between ABCD address and the DIGIT SEQUENCER. U303B is a JK flip-flop providing the RESET D. S. signal one clock time delayed. The RESET input signal, described later, also generates a RESET D. S. signal (low).

6.3.2 Digit Sequencer:

The DIGIT SEQUENCER, Figure 3, is a nine stage shift register. The first stage is the U303A. The remaining stages are provided by U302, an SN74164 eight stage shift register. The JK flip-flop advances on negative going edges while the shift register advances on positive going edges. The necessary phase reversal is provided by gate U306D.

6.3.3 Address Generator:

The ADDRESS GENERATOR, Figure 4, is a two state binary counter comprised of two JK flip-flops. The counting sequence is as follows:

A	B
0	0
1	1
0	1
1	0

6.3.4 Digit Count Logic:

The DIGIT COUNT LOGIC, Figure 5, is comprised of three NAND gates whose outputs are OR'ed. The ADDRESS GENERATOR enables the appropriate gate, whose output will go positive with a negative going from the appropriate counter input. The positive going output will advance the DIGIT SEQUENCER.

6.3.5 Counter and Clock Generator:

The COUNT AND CLOCK GENERATOR produces the system clock from the 60/50 cycle since wave input by virtue of squaring circuit U211C and U211D. The COUNT signal is then provided by counter/divier, which counts the appropriate number of clock signals. The counter consists of two decade counters, U201 and U202, preceded by two binary counters, U207. The two decade counters are connected to count binquinary. Their outputs are combined in gate U213C so that the 10/min COUNT signal is given by the JK flip-flop U210.

COMMUTATOR

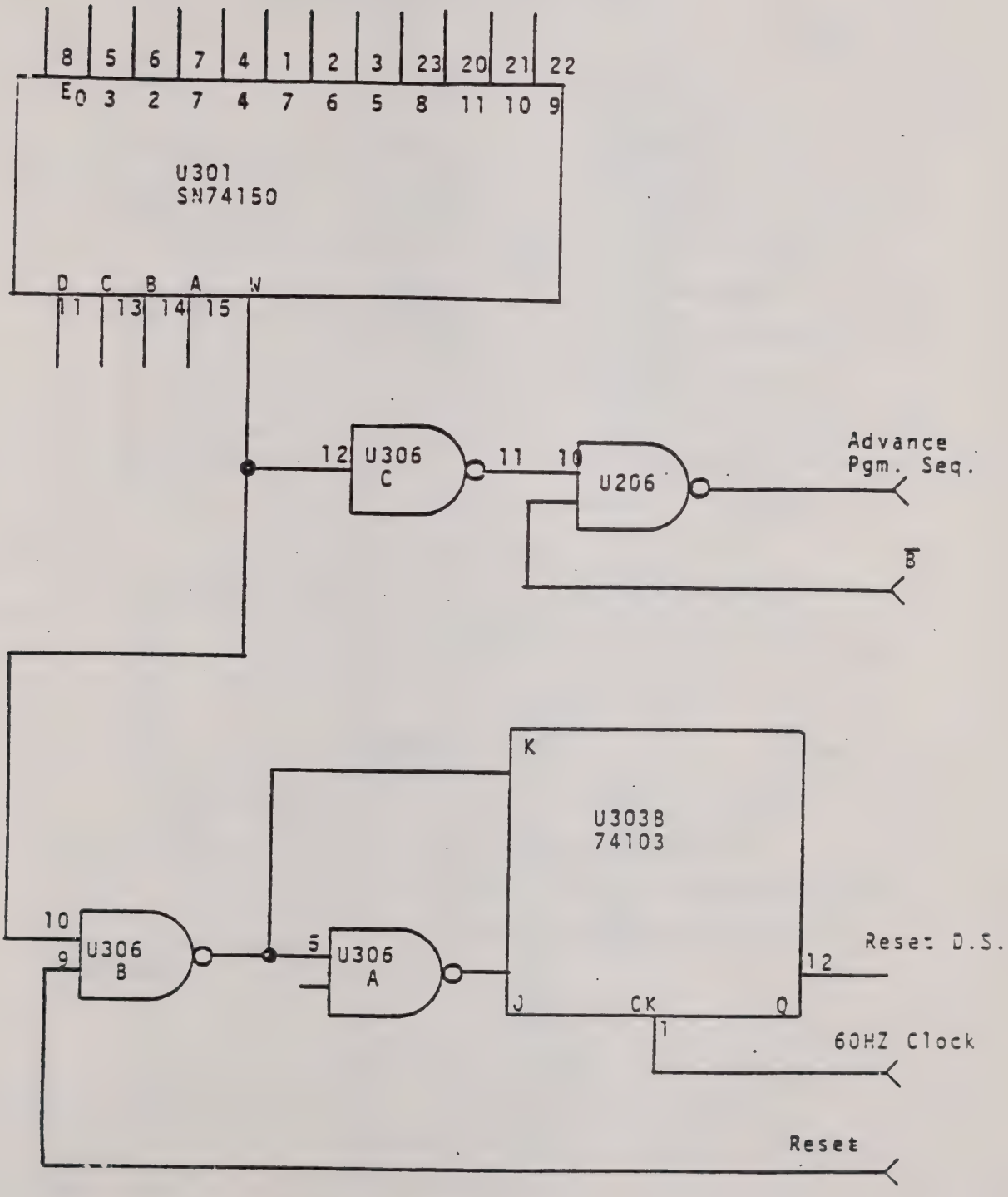


FIG.2

DIGIT SEQUENCER

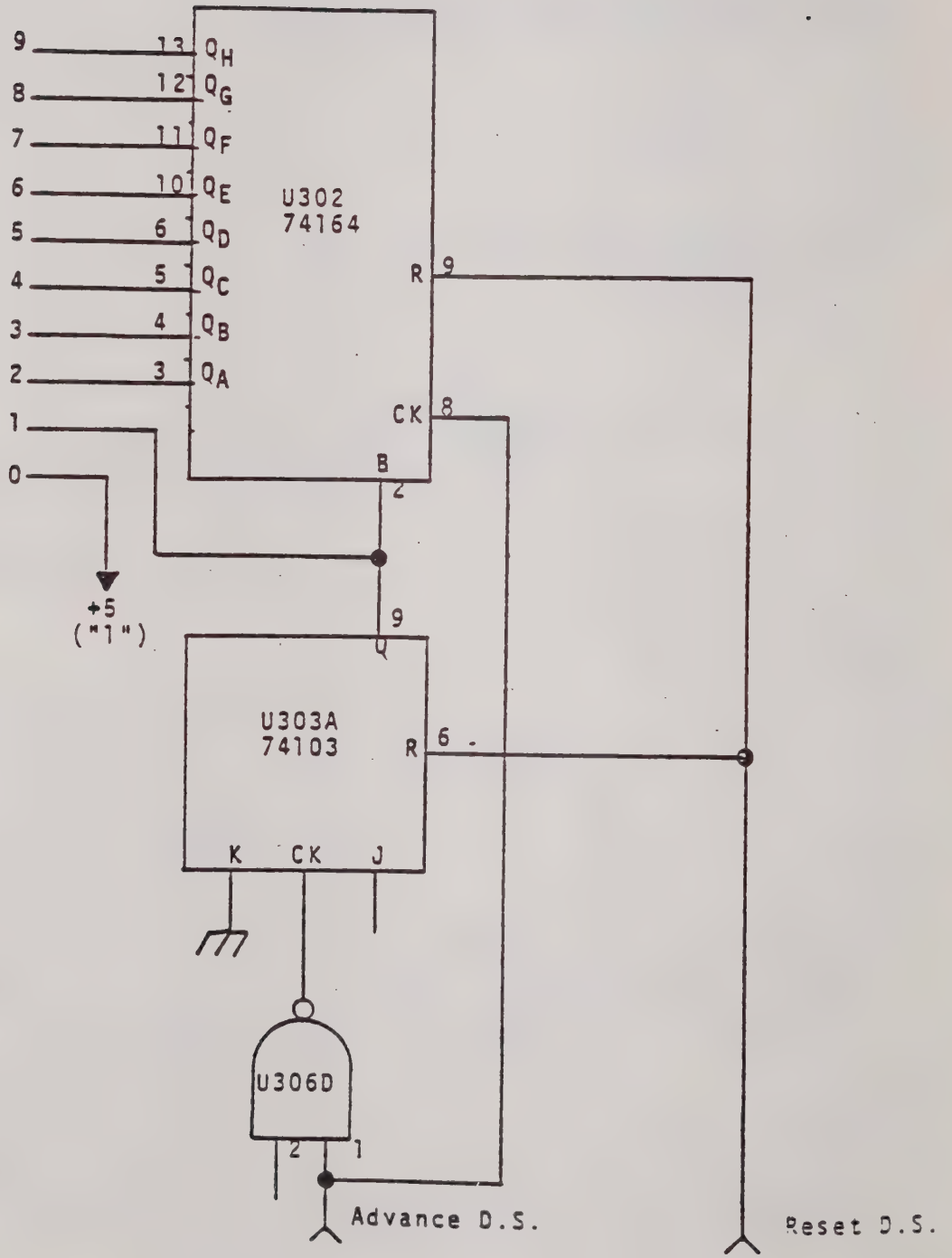


FIG.3

DIGIT COUNT LOGIC

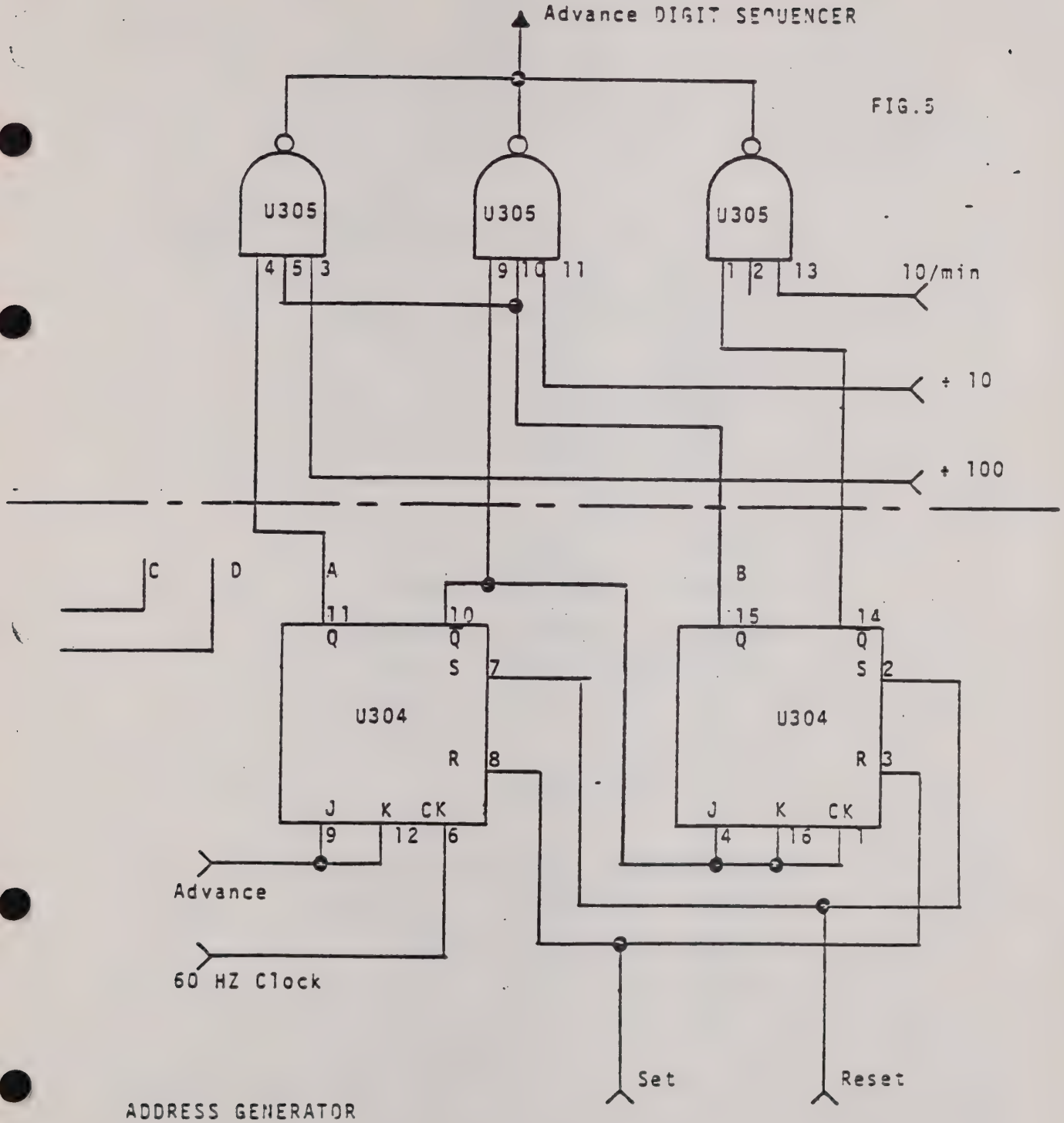
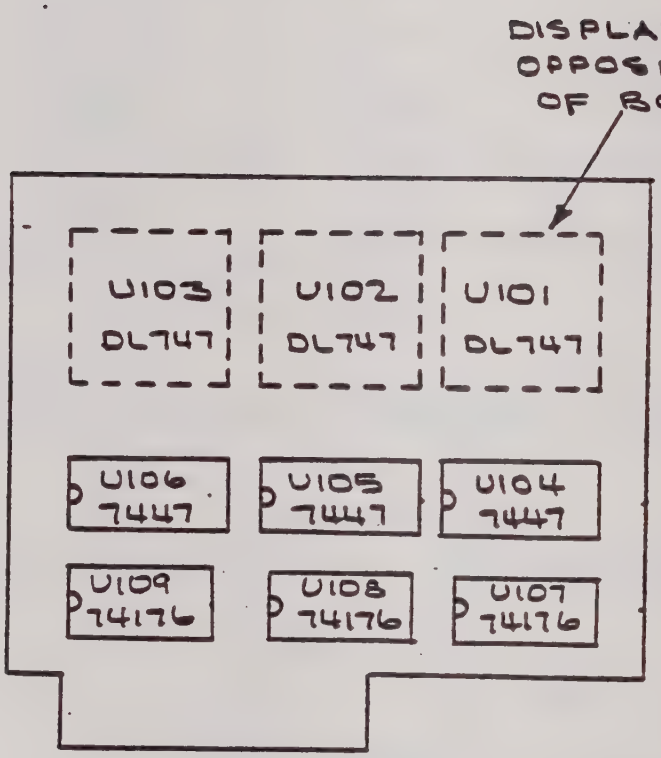


FIG.5

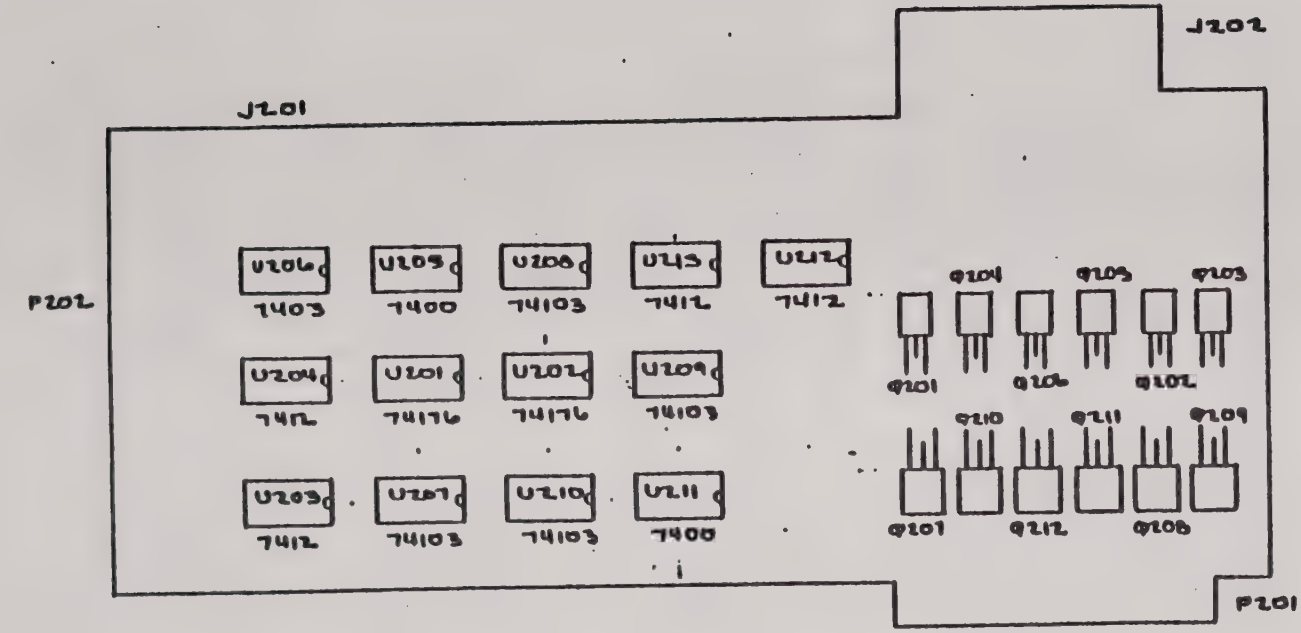
FIG.4



I.C. PAK LOCATIONS
906T DISPLAY BOARD
ASSY # 02892-001

FIG. 5

BOARDS

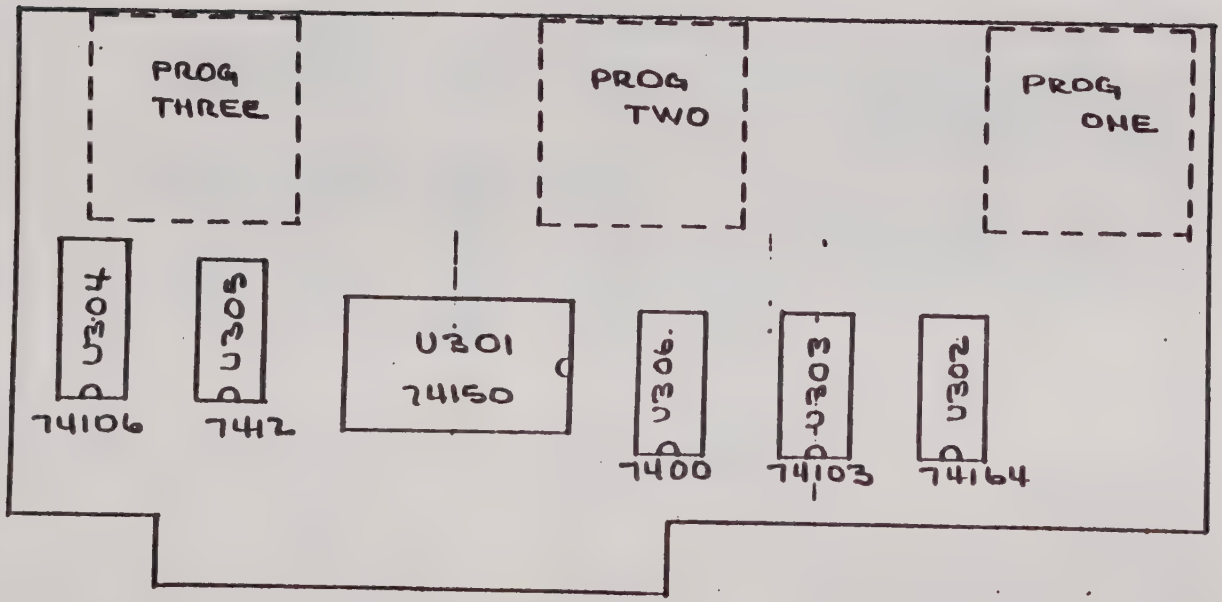


IC PAK & COMPONENT LOCATIONS

PM906T MOTHER BOARD

ASSY # 02884-001

FIG. 6



IC PAK LOCATIONS
906T THUMBWHEEL BRD.
ASSY # 02888-001

FIG. 7

6.3.6 Program Sequencer:

The PROGRAM SEQUENCER consists of three stages of binary counters and associated control logic. The counter is comprised of flip-flops FF2, FF3 and FF4 (U208 and one-half of U209). Their outputs are decoded to the eight line outputs by gates U204, U212 and U213.

FF1 drives the counter and synchronizes the various asynchronous input controls to the 60/50 cycle clock.. Gates C and D of U206 form a latch to generate one and only one advance of the counter for each depression of the front panel CYCLE switch. Gates A and B of U205 provide the SET and RESET signals for the ADDRESS GENERATOR. Either a SET or RESET signal is generated if the count is an off number.

A system clear signal is generated for each depression of the front panel RESET control by virtue of gates C and D of U205. The reset for the 10/min Generator is given by gate A of U212. The gates of U203 decode the outputs of the counter to provide the BYPASS function under control of the BYPASS switches on the front panel.

6.3.7 Triacs and Lights:

The circuitry of the TRIACS AND LIGHTS function is shown in drawing D 03208. Each triac is driven by a single transistor drive circuit. The triac in turn switches power to the appropriate relays and solenoids. Front panel lights indicating "pumpdown" are driven directly by gates of U204.

6.3.8 Vacuum Trigger:

Chamber pumpdown is terminated automatically when the pressure reaches 0.2 Torr. The base of transistor Q214 is driven by a circuit in the vacuum transducer assembly. This signal drops to zero whenever the pressure falls to less than 0.2 Torr. The collector then switches high. If the sequencer is in state, 0, 2, or 4 (a pumpdown state), the sequencer then steps to the next state.

6.4 Vacuum Meter Circuit:

The system is provided with vacuum instrumentation which, optionally, may be either the thermocouple type or capacitance manometer type. The thermocouple transducer instrument uses an analog front panel meter to display chamber vacuum level, while the capacitance manometer instrument uses a digital front panel meter. Both assemblies output vacuum trigger signals for safety interlocks and for terminating pumpdowns in automatic mode.

6.4.1 Thermocouple Vacuum Meter Circuit Description:

Refer to drawing C 10454, the vacuum meter and control circuit option schematic. The lower half of this drawing is the transducer interface and the upper half is the vacuum trigger section.

A401A, with associated resistors and capacitors, is an oscillator. This oscillator drives the primary winding of T401. At the secondary of T401 is an AC signal which drives heater elements of the thermocouple transducer.

The transducer is located at the rear of the reactor center module and it connects to J3 on the vacuum circuit board via an intermodule cable. With the heater current constant, the vacuum transducer outputs a DC voltage proportional to chamber pressure to J3, pin 8. The transducer may be calibrated by adjusting the primary current of T401 with R41 while comparing the front panel meter reading to a calibrated standard.

A402 is a comparator which is used to deenergize K401 when chamber pressure exceeds 5 Torr. The contacts of K401 are, therefore, open when pressure exceeds 5 Torr.

6.4.1 (continued)

Plus twelve volts is disconnected from pin 19 of the vacuum circuit board. This voltage is used to drive K4 in the controller (see drawing E10437),and K4 contacts connect 120 VAC to the flow solenoid valves and R. F. Control relays (K1, K2 and K3). Whenever pressure exceeds 5 Torr, reaction gas flow and RF power is disabled. The zero to minus twelve volt signal used to set RF power level is also disconnected from pin 20 of J3 when K401 is deenergized.

A401B is a comparator Pin 3 which is connected to the digital controller logic. This signal is calibrated with R40 to switch when the chamber pressure drops to 0.2 Torr. In automatic mode the digital controller uses this signal to determine when to terminate chamber pumpdown steps.

6.4.2 Capacitance Manometer Vacuum Meter Circuit Description:

Refer to drawings E10436 (2000C controller electrical schematic) and C03426 (electrical schematic, PM 410).

The MKS 222 capacitance manometer is located at the rear of the reactor center module and it connects to the vacuum trigger board via intermodule cabling. The capacitance manometer outputs a DC signal proportion to chamber pressure to J2 pin 8.

V101B is the 5 Torr comparator. Its output switches transistor Q101 which deenergizes controller relay K4 when the pressure exceeds 5 Torr. K4 then removes 120 VAC from all flow solenoid valves and RF control relays (K1, K2 and K3). This circuit prevents filling the chamber with reaction gas if the pump should fail. V101A is the 0.2 Torr comparator which provides a trigger signal at J2 pin 6 to the controller digital logic. The controller uses this signal in automatic mode to determine when to terminate pumpdown steps.

7.0 PREVENTIVE MAINTENANCE

PLASMA REACTORS AND VACUUM COMPONENTS

These items comprise the plasma chemical portions of the Plasma System. They are subjected to the greatest use, physical wear and chemical deterioration. Thus preventive maintenance of these items is of prime importance.

7.1 Vacuum Pump:

The mechanical fore pump is in continuous operation during the life of the system.. First, it is recommended that the pump be kept running continuously. The meter, bearings and other pump components are designed for continuous operation.

7.1.1 Pump Oil:

Oxidation products are continually being passed through the pump oil during operation of the machine. These products include water vapor, carbon dioxide, nitrogen oxide and, possibly, halogens or other corrosive gases. In addition to dissolving in the pump oil, some of these products can contribute to the chemical breakdown of the pump oil, increasing its viscosity, raising its vapor pressure, and "gumming up" the inside portions of the pump mechanism.

When employing the plasma System for the stripping of photoresist from silicon wafers, it is recommended that the pump oil be changed (in accordance with procedures outlined in the pump manual) after processing each 100,000 wafers. This figure assumes 2" diameter wafers, coated with 10,000 A of photoresist.

If one routinely processes larger or smaller wafers with difference resist thickness, correction can be made for the stripping of an equivalent total mass of photoresist to determine the oil changing schedule. Weekly checks are recommended to determine proper frequency of oil changes.

7.1.2 Input Filter Screen:

The vacuum pump contains a small fiber screen at its inlet. This screen collects small bits of silicon chips or other particulate material, which can act as condensation parts for pump oil vapor, with the result that the screen can become clogged with time, thus reducing the pumping speed of the pump.

This screen should be cleaned at least as often as the pump oil is changed. In any initial installation it is recommended that the screen be examined initially on a monthly basis (if the above schedule extends longer than one month) to observe the rate of material accumulation at the particular installation, and a filter cleaning schedule then be established based upon this observation.

7.1.3 Purge Valve:

At least once biweekly the purge valve on the pump should be opened slightly for a 24 hour period to allow air to diffuse through the pump to remove accumulated water vapor and other volatiles from the pump oil. The valve should be opened slighlty until a change is heard in the sound of the pump under vacuum.

7.1.4 "O" Rings:

The system contains one or more Reactors, each one with one large O-ring or bell jar gasket at the window. During use these O-rings can become stiff and inflexible and eventually develop hairline cracks. To eliminate incipient leaks caused by this, and to avoid the possible failure of a brittle O-ring during use, it is recommended that these O-rings be replaced after each 500 hours of acutal plasma operation.

7.1.5 Exhaust System:

Each of the Plasma Reactors is connected to the vacuum system by means of a flexible metal bellows assembly. At either end of this bellows assembly is a vacuum fitting which contains 3/4" silicone O-ring. These O-rings should be replaced on a routine basis as determined by visual inspection to eliminate the possiblity of unforeseen leaks.

7.2 R. F. Generator:

For maintenance instructions on R . F. Generator please refer to Section 5.0 of the GENERATOR section of the manual.

7.3 Programming Logic, Timers, and Other Digital Control Modules:

7.3.1 Controller Regulated Power Supply:

The Process Controller contains a ± 5 and ± 15 volt regulated power supply which is used to operate the digital circuitry. Part of your maintenance should consists of checking and calibrating the voltage at least once every three months. A standard 20,000 ohm per volt ohmmeter will be adequate to do the job. Refer to the information on the power supply at the end of this manual section.

7.3.2 Switches and Controls:

The Controller should be placed first in manual operation and the switches should be manually operated in their normal operation procedure several times, rapidly, while carefully observing the specified performance to the unit. Particular attention should be paid to the operation of any one of the switches giving indication of possible future failure. Should either of the switches or pushbutton assembly exhibit an intermittent characteristic, the component should be replaced.

7.3.3 Gas Flow System:

The gas flow system contains four gas switching valve assemblies and three needle valves. This constitutes the mechanical portion of the gas flow system which is normally operated in conjunction with three toggle switches which operate the needle valve assembly. The Swagelock connections should be checked and tightened periodically.

7.3.4 Switching Relays:

The control unit contains enclosed relay switching elements. These should be physically removed from their sockets and a visual inspection should be given to the closure contained within, paying particular attention to any pitting on either of the base contacts operated by the contact assembly.

Relays showing visible spots where pitting has occurred should be replaced. Generally, even with heavy operation and service, the relays should not require replacement at intervals of less than six for the worst case.

7.3.5 Interconnecting Cable Assemblies:

The interconnecting cable assemblies should be completely removed from the system and inspected for dust and residue accumulation. This is particularly true in the case of the cable assembly which interconnects the Process Controller and the Reactor. The cable assembly consists of a large multiple-pin connector and is subject to dust accumulation built up within the contact area. This may be cleaned by an application of air from a compressed air source.

!CAUTION!
BE SURE TO USE ONLY COMPRESSED AIR SOURCE FREE OF MOISTURE.

8. CAPACITANCE MANOMETER OPTION

8.1 INTRODUCTION

This option employs a capacitance pressure sensor and provides continuous digital readout of pressure in torr (mm/Hg). The digital display is 4-1/2 digits. This option is designed to operate at pressures less than 10 Torr; hence, the maximum reliable readout is +09.99 Torr. It provides digital "set-point" outputs which switch when pressure reaches a preselected level. The number the type of digital "set-point" output is described in Section 8.2.

Disregard reference in Section 4.2 to Torrmeter calibration and the associated Figure 1.

8.2 CIRCUIT DESCRIPTION

Refer to drawings C10497, the schematic diagrams for this option comprised of the following:

1) A capacitance manometer
2) A DC voltmeter
3) Vacuum trigger or "set-point" circuit boards.

The pressure transducer provided outputs a zero to ten volt DC signal proportional to pressure. The voltage level is continuously displayed on the digital voltmeter. One volt is equivalent to one Torr. When pressure rises above ten Torr, the voltmeter displays higher readings; however, these readings are not accurate.

The set points are preselected with R102 and R104. These settings should be near 5 Torr and .2 Torr respectively.

U101B compares the transducer signal voltage level to the level at the wiper arm of R102. Q102 (open collector) and Q101 switch "ON" when pressure rises above the present level.

U101A compres the transducer signal voltage level to the level at the wiper arm of R104. When pressure rises above the preset level U101A pin 1 switches from -14 volts to +14 volts.

8.3 CALIBRATION

The power supply, voltmeter, and transducer are calibrated in the factory. Frequent recalibration should not be necessary. If it becomes necessary to recalibrate any subassembly allow one hour warm up. The power supplies should be adjusted to +15 volts and -15 volts. (The adjustment potentiometers are clearly labeled on the power supply printed circuit card). The transducer power unit, mounted on the rear panel of the Torr module, has a screw driver adjustment for calibration. Calibration of the transducer should be done at base pressure by comparison with an accurate standard. Calibration of the voltmeter may be done according to the appended instruction sheet.

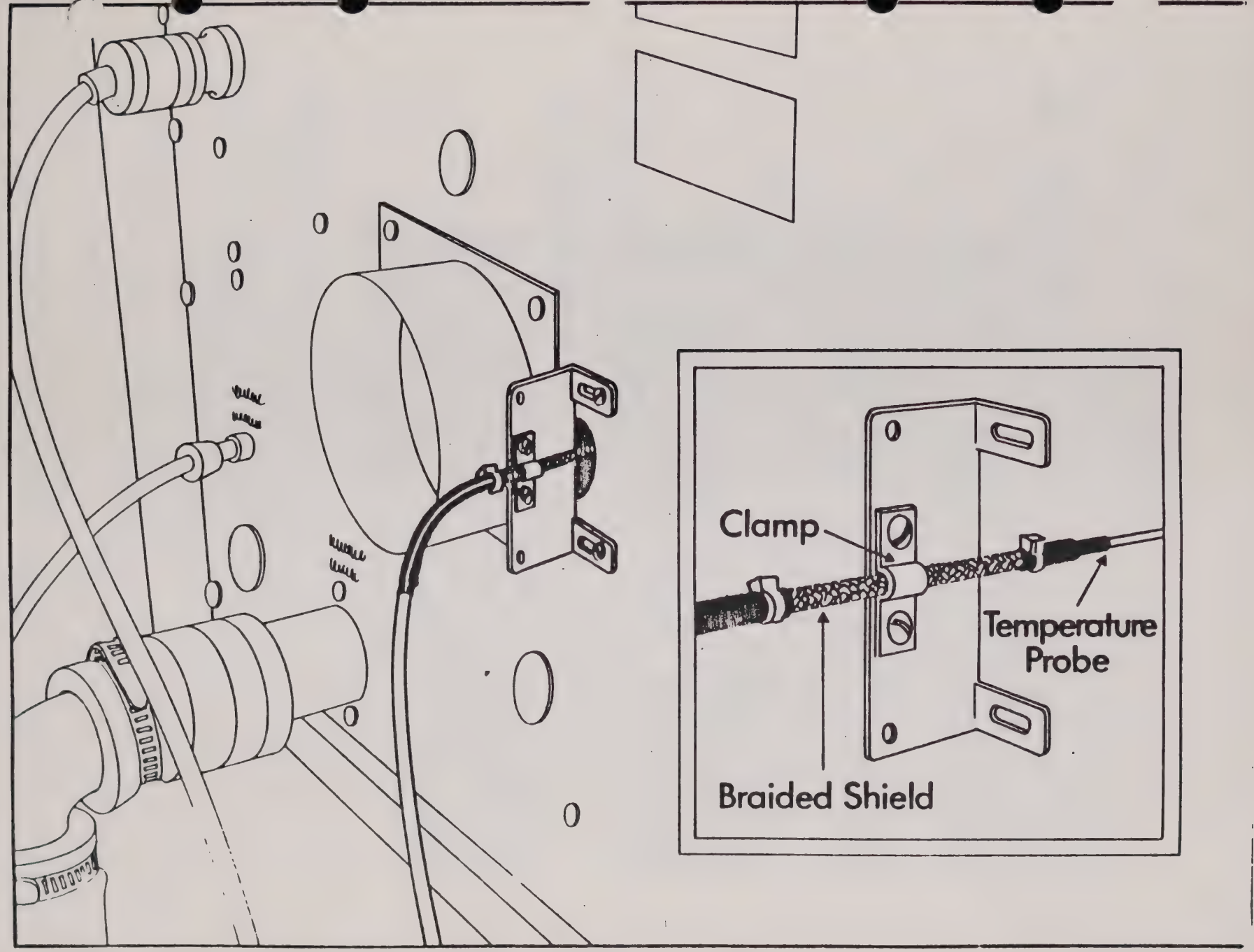


FIG. 1

9. TEMPERATURE CONTROL OPTION

9.1 INTRODUCTION

This option continuously monitors Reactor Chamber temperature and displays the temperature (degrees Celsius), on a front panel digital read-out. Also included on the front panel are thumbwheel switches for pre-selecting an upper temperature limit.

A Plasma Processing Program is defined as a complete plasma process using a particular reaction gas and a particular R.F. power level. IPC Plasma Processing machines which automtically perform two or more sequential Programs may include this option to provide for a "pre-heat" Program. In this case, when it detects that the Reactor Chamber temperature coincides with the temperature pre-selected with the front panel thumbwheel switches, it outputs a signal which causes the Plasma machine to step from the first Program in the second Program. During the second and any subsequent Programs, it has no affect upon the Plasma System; however, it continues to display temperature.

9.2 INSTALLATION

All interconnect cables should be properly installed before power is switched on. The temperature sensing probe is equipped with a ground strap which must be secured firmly (mechanically and electrically) to the rear panel of the Reactor Center. The probe is inserted into the Chamber through a glass port at the rear of the Reactor. See Figure 1 for probe installation

!CAUTION!
It has been determined that there is a potential electrical shock hazard with the Temperature Probe installed in Branson/IPC Gas Plasma Systems. The Temperature Probe should be clamped by the braided shield in order to assure a proper ground. Improper grounding could cause R.F. pick-up in the cable and represents a possible shock hazard to anyone contacting the cable while the R.F. is on.

9.3 INITIAL OPERATION

9.3.1 Front Panel Controls

Three decade thumbwheel switch determines the "coincidence" temperature when operating with the Process Controller. This thumbwheel switch should not be set higher than 199. Units are degrees CELSIUS.

9.3.2 Front Panel Indicators

Temperature

Three decade digital display of the temperature of the Reactor Chamber. Units are degrees CELSIUS.

9.3.3 Normal Process Controller Operation

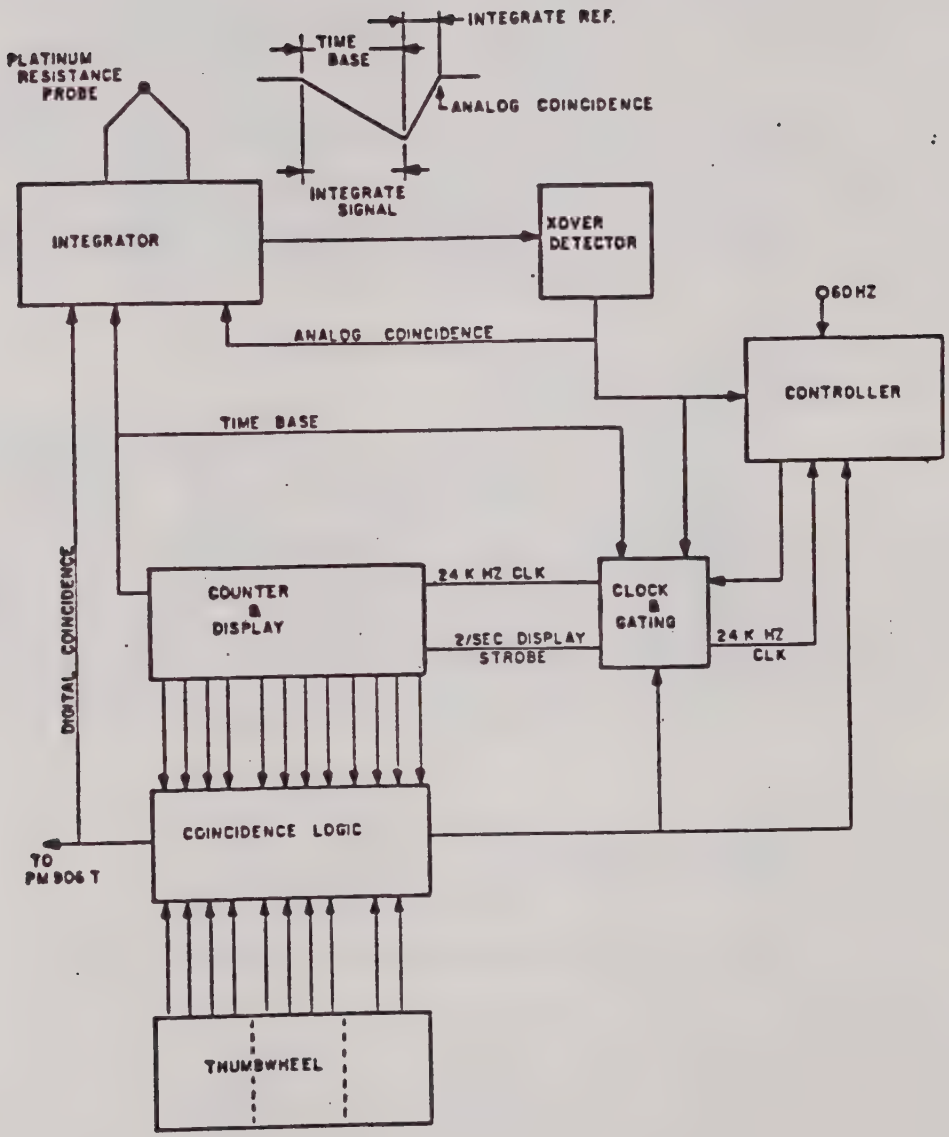
Set AC POWER Switch to ON, and the PROGRAM 1 switch to TIME. The Process Controller will then operate as normal and the duration of Program 1 is determined by the setting of thumbwheel switches on the front panel of the Process Controller.

9.3.4 Program 1 Preheat

Set the PROGRAM 1 switch to TEMP. Set the thumbwheel switches on the front panel to the desired preheat temperature in degrees CELSIUS. (Do not exceed a setting of 199). The Process Controller will operate as normal except the duration of the first Program will be determined by the Temperature Option and will advance to the second Program when the temperature reaches the value set on the front panel thumbwheels. The temperature will be controlled only if the RF power level used during the subsequent Programs is less than is required to maintain the Chamber at the set temperature.

9.4 FUNCTIONAL DESCRIPTION

The block diagram is showin in Figure 2. It consists functionally of an analog-to-digital Converter, which converts the resistance to the temperature sensitive probe to a digital representation of the temperature; and a Controller, which compares the temperature with the value set on the front panel switches. The Controller also generates a signal signifying coincidence between the measure temperature and the set temperature and transmits this signal to the Process Controller.


INTEGRATE REF.
TIME BASE
PLATINUM RESISTANCE PROBE
ANALOG COINCIDENCE
INTEGRATE SIGNAL
INTEGRATOR
XOVER DETECTOR
60HZ
ANALOG COINCIDENCE
CONTROLLER
TIME BASE
DIGITAL COINCIDENCE
COUNTER & DISPLAY
24 K HZ CLK
CLOCK & GATING
2/SEC DISPLAY STROBE
24 K HZ CLK
COINCIDENCE LOGIC
TO PM 906 T
THUMBWHEEL

9.4 Figure 2

9.4.1 Analog-to-Digital Converter

The analog-to-digital Converter is comprised of the four functional blocks; the INTEGRATOR, the XOVER DETECTOR, the COUNTER AND DISPLAY, and the CLOCK AND GATING. The Converter is basically a dual ramp type, whereby the INTEGRATOR first integrates a current proportional to the probe resistance or temperature for a fixed time, and then integrates a reference current of opposite polarity until the integrated value returns to its original value. The time required to integrate the reference is then representative of the probe temperature. This time interval, as well as the time interval of probe integration, is measured digitally by the COUNTER AND DISPLAY. It includes a digital Counter which counts the output of a reference oscillator. The first integrating interval is determined by the time required for the Counter to count to full scale, i.e. 199. The Counter then counts the time required for the second integrating interval and the resulting value is displayed on the front panel.

9.4.2 Controller

The Controller is comprised of the three functional blocks; the CONTROLLER, the COINCIDENCE LOGIC, and the THUMBWHEEL SWITCHES. The Coincidence Logic detects coincidence between the Counter and the setting of the Thumbwheel Switches during the second integrating interval. A signal denoting coincidence is generated and transmitted to the Proces Controller. The Controller measures the difference between coincidence and the measured temperature by counting the number of reference clock cycles that analog coincidence (end of the second integrating interval) exceeds digital coincidence.

9.5 CIRCUIT DESCRIPTION

The Temperature Option is shown schematically in drawing D02905.

9.5.1 Clock and Gating

The reference oscillator is comprised of amplifier U113A and surround circuitry. R106 provides fine adjustment of the frequency which is 24KHZ. Inverters U112A and U104A shape the output wave form consistent with TTL requirements.

Division of the two period 60/50 cycle period into four parts requires the generation of 120HZ pulses synchronous with the input power. This is accomplished by amplifying the input via U113B for easy detection of zero cross-over. The outputs of inverters U104B and U123A are then two 60/50HZ square waves of opposite polarity. Each output is differentiated by the capacitor-resistor circuitry C107, R119, R118 and C108, R120, 121. The resulting narrow pulses are shaped by the inverters of U123, and the output of gate U117A is a wave form of 120HZ positive going pulses.

Since a full sequence requires 33.3 milliseconds, it would be disconcerting to the eye to display every conversion. Therefore only one of sixteen conversions is selected for display. for an update of approximately two per second. The four stage binary counter of U116 divides the "analog coincidence" signal (there is one per sequence and will be described later). Its output is differentiated and then shaped by U112B, which output is used to update the digital display.

Gate U11 provides the gating of the Clock to the Counter. Its other inputs will be described later.

9.5.2 Counter and Display

The system Counter, whose full count is 199, consists of three decades of binary-coded-decimal. These are U105, U106, and U107. Their outputs are decoded by U108, U109, and U110; then buffered by U201, U202, and U203, which drive the LED displays. The serial output of the Counter drives flip-flop U114A to establish the end of the first integrating interval.

9.5.3 Integrator

The integrator is comprised of an operational amplifier, U121 with a feed-back capacitor C103. The voltage at the output of the amplifier is the integral of the current into the amplifier-capacitor combination. The input is switched between the probe signal and the reference current by the FET switches of U122. The reference current is given by the series combination of the negative 15 volt supply and resistors R111 and R110. The probe is connected directly to the positive input terminal of the amplifier, and a nearly constant current forced through it by the negative 15 volt supply through R128. The voltage at the positive terminal then varies with the temperature of the probe. A nearly constant voltage is generated at the input to FET switch B. Thus when FET switch B closes the current into the amplifier is proportional to the temperature of the probe. Potentiometers R109 and R111 serve as offset as scale adjustments respectively.

9.5.4 Xover Detector

The cross-over detector, which signals the end of the second integrating interval, consists of amplifier U121B. Inverters U118A and B and capacitor C104 form a pulse shaping network. The outputs of this network, A and A, signify the end of the second integrating interval. Signal A is sometimes referred to and "analog coincidence".

9.5.5 Controller

The heart of the Controller is the two stage binary Counter U115. Its serial output sets the flip-flop of U114B, which signifies that the Counter has counted to four. At the start of each sequence the Counter is set to zero. The start of a sequence is either digital coincidence, D, or analog coincidence, A., whichever comes first. If D preceeds A, which is the condition if the temperature of the probe is too hot, the Counter proceeds to count the 24KHZ clock pulses until A occurs. At this time the Counter ceases to count the 24KHZ pulses and proceeds to count the 120HZ pulses.

The reset pulse starting each sequence is generated by a latch comprised of U119C and U120C. The latch is set with the first occurrence of analog or digital coincidence, i.e., A. or D. The negative going edge at the output of U120C is differentiated, and the resulting pulse is the reset for the Counter. The latch is reset by U114A at the beginning of the second integrating interval.

In order to maintain digital coincidence during the interval starting with digital coincidence and ending with analog coincidence, the main Counter (part of COUNTER AND DISPLAY) must be stopped. This is accomplished by the appropriate combinations of D, A, U114A, and U114B in the gate of U111.

9.5.6 Coincidence Logic

Coincidence between the setting of the front panel thumbhweel switches and the main Counter (referred to previously as digital coincidence of D) is accomplished by the gate structure of U101, U102, and U103. The inverters of U112 and U104 provide the correct polarity to the gates. The outputs of the gate structure is inverted by an inverters of U118, and "latched" by gates A and B of U123. This latched output is transmitted to the Process Controller. The latch is reset by signal D from the Process Controller.

Power-One INC.

D.C. POWER SUPPLIES

INTERNATIONAL SERIES
DC POWER SUPPLIES

DRAWING NO. 51281 REV. D

SPECIFICATIONS AND APPLICATION DATA

INTERNATIONAL SERIES DESCRIPTION

The INTERNATIONAL SERIES is a high reliability line of open-frame power supplies designed to operate from the wide range of AC power sources found worldwide.

This feature greatly simplifies your inventory and service considerations by allowing the use of one standard power supply regardless of destination.

tionally, these models are designed to meet many domestic and European regulatory agency requirements.

If you plan to distribute your products worldwide, obtaining necessary agency approvals can be greatly simplified by specifying POWER-ONE, INC. INTERNATIONAL SERIES.

VOLTAGE/CURRENT RATING CHART

MODEL	+5V	+12V	+15V	+24V	+28V	-5V	-12V	-15V	CASE
SINGLE OUTPUT									
MB5-3/OVP-A	3.0								B
MB12-1.7-A		1.7							B
MB15-1.5-A			1.5						B
MB24-1.2-A				1.2					B
MB28-1-A					1.0				B
MC[illegible]-4/OVP-A	6.0								C
M[illegible]-4-A		3.4							C
M[illegible]-A	-		3.0						C
ML[illegible].4-A				2.4					C
MC28-2-A					2.0				C
MN5-9/OVP-A	9.0								N
MN12-5.1-A		5.1							N
MN15-4.5-A			4.5						N
MN24-3.6-A				3.6					N
MN28-3-A					3.0				N
MD5-12/OVP-A	12.0								D
MD12-6.8-A		6.8							D
MD15-6-A			6.0						D
MD24-4.8-A				4.8					D
MD28-4-A					4.0				D
ME5-18/OVP-A	18.0								E
ME12-10.2-A		10.2							E
ME15-9-A			9.0						E
ME24-7.2-A				7.2					E
ME28-6-A					6.0				E
DUAL OUTPUTS									
MAA15-0.8-A		1.0 or 0.8				†0.4 or 1.0 or 0.8			AA
MBB15-1.5-A		1.7 or 1.5				†0.7 or 1.7 or 1.5			BB
MCC15-3-A		3.4 or 3.0					3.4 or 3.0		CC
MDD15-5-A		5.0 or 5.0					5.0 or 5.0		E
MAA512-A	2.0	*0.5	*0.5						AA
MBB512-A	3.0	*1.25	*1.25						BB
MCC512-A	6.0	*2.5	*2.5						CC
TRIPLE OUTPUTS									
MTAA-16W-A	2.0	*0.4	*0.4			†0.4 or *0.4	or *0.4	or *0.4	AA
MBAA-40W-A	3.0	1.0 or 0.8				†0.4 or 1.0	or 0.8		BAA
MCAA-60W-A	6.0	1.0	or 1.0			†0.4 or 1.0	or 1.0		D
MBB-75W-A	6.0	1.7 or 1.5				†0.7 or 1.7	or 1.5		CBB
CP131-A	8.0	1.7 or 1.5				†0.7 or 1.7	or 1.5		131
MDBB-105W-A	12.0	1.7 or 1.5				†0.7 or 1.7	or 1.5		DBB

DISC DRIVES MODEL	+5V	+12V	+24V	-5V	-12V	-15V	
C[illegible]-A	6.0		3.5 (3.0 PK)	1.2	1.2		131
[illegible]A	9.0		2.0 (8.0 PK)	1.2	1.2		131
[illegible]-A	2.0	4.0					N
CP205-A	1.0		1.5 (1.7 PK)	0.5			BAA
CP206-A	2.5		3.0 (3.4 PK)	0.5			CBB
CP162-A	3.0		5.0 (6.0 PK)	0.6			131

*9V to 15V Floating Output
†Requires jumper on PCB for -5V
Underlined output indicates no remote sense

FEATURES

- VDE transformer construction
- 100/120/220/230-240 VAC
- Remote sense - most outputs
- OVP on 5V outputs
- ±.05% regulation
- Industry standard size
- Foldback/current limit
- Full-rated to 50°C
- I.C. burned-in to MIL-883 Lev B
- 2 hour burn-in period
- Two year warranty
- UL recognized
- CSA certified
- Chassis notched for AC input
- Input accepts .110 x .032 fast-on or solder connection

SPECIFICATIONS

AC INPUT:	100/120/220/230-240VAC** +10%, -13% 47-63 Hz (Derate output current 10% for 50 Hz operation.) See AC connection table under APPLICATION NOTES for jumper information. Fuse information is next to outline and mounting drawings.
DC OUTPUT:	See Voltage/Current Rating Chart. Adjustment range ±5% minimum.
LINE REGULATION:	±.05% for a 10% line change
LOAD REGULATION:	±.05% for a 50% load change
OUTPUT RIPPLE:	2V to 15V unit: 5.0mV PK-PK maximum 20V to 200V unit: .02% PK-PK maximum
TRANSIENT RESPONSE:	50μseconds for 50% load change
SHORT CIRCUIT AND OVERLOAD PROTECTION:	Automatic current limit/foldback
OVERVOLTAGE PROTECTION:	Built-in on all 5V outputs. Set at 6.2V ± .4V. Other models use optional overvoltage protection
REMOTE SENSING:	Provided on most models, open sense lead protection built-in
STABILITY:	±0.3% for 24 hour period after 1 hour warm-up
TEMPERATURE RATING:	0°C to 50°C full-rated, derated linearly to 40% at 70°C
TEMPERATURE COEFFICIENT:	±.03%/°C maximum
EFFICIENCY: (typical)	5V unit: 45%; 12V and 15V units: 55% 20V and 24V units: 60%
VIBRATION:	Per MIL-STD-810C, Method 514, Procedure X
SHOCK:	Per MIL-STD-810C, Method 516, Procedure V

**Tolerance for 230VAC operation is +15%, -10%

WARRANTY

POWER-ONE, INC. warrants each power supply of its manufacture that does not perform to published specifications, as a result of defective materials or workmanship, for a period of two (2) full years from the date of original delivery.

POWER-ONE, INC. assumes no liabilities for consequential damages of any kind through the use or misuse of its products by the purchaser or others. No other obligations or liabilities are expressed or implied.

PRODUCTS RETURNED FOR REPAIR

Please follow this procedure when returning products for servicing:

1. Contact Power-One's Customer Service Department for authorization to return products.

POWER-ONE, INC.
740 Calle Plano
Camarillo, CA 93010
USA

PHONE: (805) 484-2806
(805) 987-3891
(800) 235-5943
TWX: 910-336-1297

2. A Returned Material Authorization (RMA) will be issued and must appear on all shipping documents and containers.
3. Products must be returned freight pre-paid.

Products returned freight collect or without a RMA number will be rejected and returned freight collect

REMOTE SENSE

Remote sense terminals may be used to compensate for output line loss and provide for a remote point of regulation. Figure 1 shows the proper termination for a power supply with remote sensing.

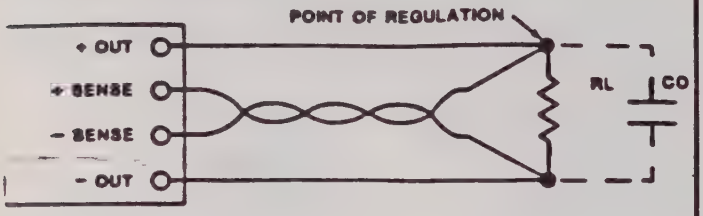


FIGURE 1

Load lines must be sized to prevent an excessive voltage drop from the output to the load. Since the point of regulation is at the load, the power supply must compensate for line losses. Excessive load line losses may affect current limiting, AC line dropout point and OVP margin (if applicable).

Leads should be sized to drop no more than 0.5V - the less the better. Use of a twisted pair or shielded pair for the sense lines is recommended for noise immunity. In problem applications, the use of a small AC decoupling capacitor (.1 to 10uFd) across the sense terminals is highly recommended. In some applications there may be a tendency for the power supply to oscillate due to the additional phase shift caused by the series resistance and inductance in the load leads. The addition of capacitor Co will reduce output impedance and provide stability. The recommended value of Co is 100uFd per ampere or 50uFd per inch and can be the sum of the distributed decoupling capacitors found in most systems.

All Power-One supplies have open sense lead protection to protect the load from an overvoltage condition if the sense leads are removed. There is no need to strap the sense terminals to the output terminals in the local sense mode.

OVERVOLTAGE PROTECTION (OVP)

An overvoltage protection circuit, commonly referred to as a crowbar, is used to prevent damage to voltage sensitive loads such as TTL logic. Trip point of the OVP is usually set at 115% - 135% of the output voltage. The OVP will short the output terminals upon sensing a fault condition. The primary fuse of the supply will blow if the supply is not foldback current limited. Nuisance tripping of the OVP is a common problem. Noise from input line spikes or load noise can cause an OVP to fire. The INTERNATIONAL SERIES has OVP noise filtering to prevent nuisance tripping and reduced transformer interwinding capacitance to minimize input line susceptability.

COMMON-MODE LATCH UP

In certain instances dual power supplies can exhibit a problem known as common-mode latch up. This occurs when the positive supply comes up first and forces a reverse bias condition on the negative supply. The negative supply latches up in a current limit condition. Power-One has incorporated a unique anti-latch circuit into every dual power supply in the INTERNATIONAL SERIES which will minimize this problem.

EMI/RFI

These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet the requirements of FCC Docket 20780 for Class A equipment and VDE 0871 for Class A equipment without additional noise filtering. For special applications consult factory.

PRINTED CIRCUIT BOARDS

POWER-ONE, INC.'s printed circuit board fabrication facility is recognized under the component program by Underwriters Laboratories. All PC boards meet UL 94V-0 flammability specification.

SAFETY SPECIFICATIONS

The INTERNATIONAL SERIES power supplies were designed to meet or exceed requirements for the following specifications: IEC 380, IEC 435, VDE 0730 Part 2, VDE 0804, ECMA-57, CEE 10 Part 2P, UL 1012, CSA 22.2 No. 143, CSA 22.2 No. 154. Specifically, field terminal to terminal spacing is 5.25 mm with 9.0 mm creepage to other metal, leakage current is less than 5.0uA and dielectric withstanding voltages are 3750 VAC input to chassis, 3750 VAC input to output and 300 VDC output to chassis.

GROUNDING

Grounding considerations in designing a power distribution system are often overlooked but can have a significant impact on overall system performance. A single point system ground should be employed where possible to eliminate ground loops and improve regulation.

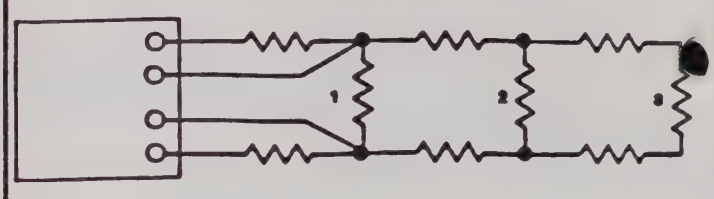


FIGURE 2

FIGURE 3

Figure 2 shows a simple but undesirable connection scheme. Regulation at loads 2 and 3 becomes progressively worse due to voltage drops in the finite wire resistance between loads. Figure 3 shows an improved connection system in which regulation is maintained at all three loads because wire losses are not cumulative.

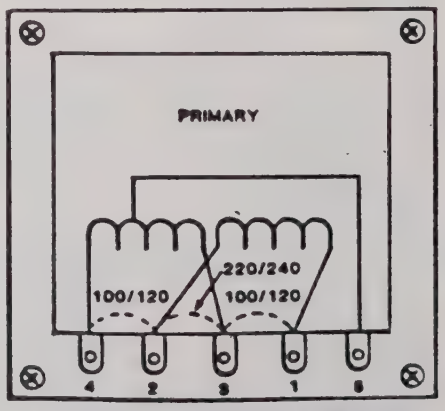
AC INPUT CONSIDERATIONS

Almost all power supplies use a capacitive input filter that draws current only at the peaks of the AC input voltage. The peak to RMS ratio can be very high, typically 3 to 1. When a supply is turned on, the input capacitor has a very low impedance and draws an initially high surge current until it charges to its nominal voltage. The input surge current can be as high as 20 times the rated input current and lasts for several cycles of the AC input.

AC CONNECTION AND FUSING *

The five wire input to the INTERNATIONAL SERIES provides four voltage ranges: 100/120/220/230-240** +10%, -13%. See chassis AC connection table (Figure 4) for the jumpering requirements. For convenience the jumper sequence from the Hi-Vol series is retained. Extended low line tolerance provides additional drop out margin in areas where line voltages are marginal. Inputs must be fused.

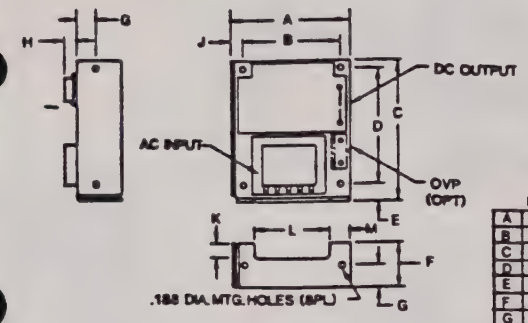
FIGURE 4



AC INPUT, 47-63 HZ				
FOR USE AT	100 VAC	120 VAC	220 VAC	230/240 VAC
JUMPER	1&3 2&4	1&3 2&4	2&3	2&3
APPLY AC	1&5	4&1	1&5	4&1

*NOTE: Use 700°C. iron for soldering input connections. Varnish acts as flux and is solder strippable.
**Tolerance for 230VAC operation is +15%, -10%.

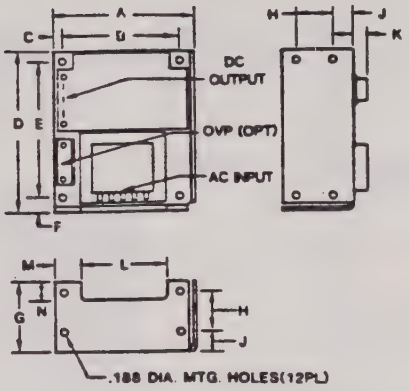
B CASE
WT. 2LBS.



	INCH	mm
A	4.00	101.60
B	3.375	85.73
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.62	41.15
G	0.75	19.05
H	0.450	11.43
J	0.38	9.65
K	0.57	14.48
L	2.60	66.04
M	0.794	20.17

FUSE AT: 0.8/0.25 AMPS FOR 100-120/220-240 VAC

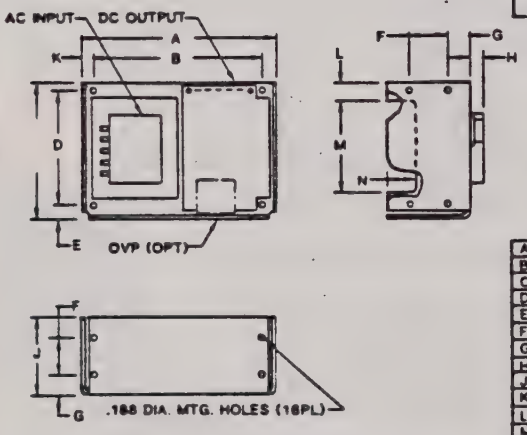
C CASE
WT 4LBS



	INCH.	mm.
A	4.87	123.70
B	4.125	104.78
C	0.25	6.35
D	5.62	142.75
E	4.875	123.83
F	0.50	12.70
G	2.50	63.50
H	1.250	31.75
J	0.75	19.05
K	0.450	11.43
L	2.85	72.39
M	1.025	26.04
N	0.665	16.89

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

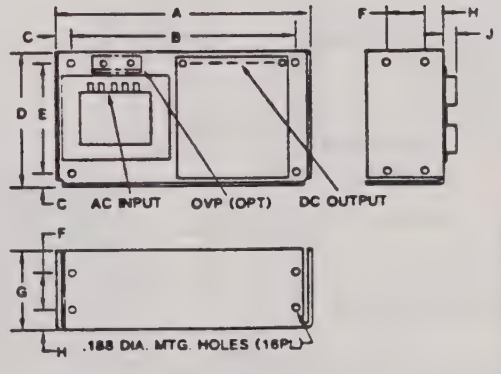
N CASE
WT. 6LBS.



	INCH	mm
A	7.00	177.80
B	6.250	158.75
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.250	31.75
G	0.75	19.05
H	0.450	11.43
J	2.75	69.85
K	0.38	9.65
L	0.640	16.26
M	3.35	85.09
N	1.00	25.40

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC

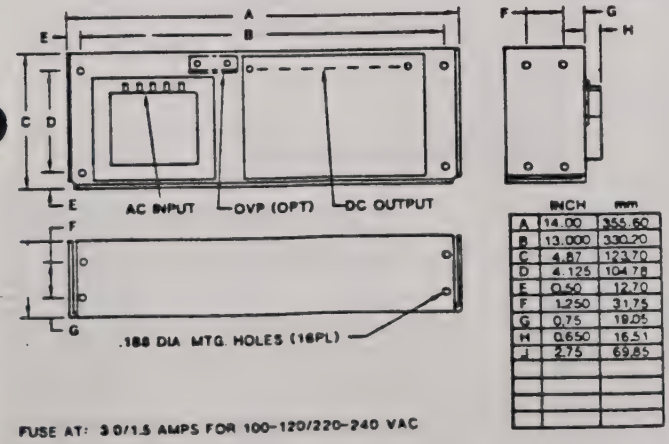
D CASE
WT 7.5LBS.



	INCH.	mm.
A	9.00	228.60
B	8.000	203.20
C	0.50	12.70
D	4.87	123.70
E	4.125	104.78
F	1.250	31.75
G	2.75	69.85
H	0.75	19.05
J	0.450	11.43

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC

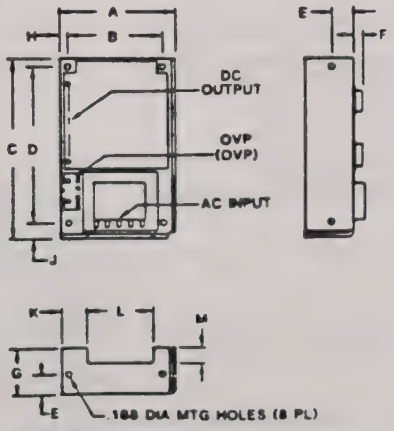
E CASE
WT. 10LBS



	INCH	mm
A	14.00	355.60
B	13.000	330.20
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.250	31.75
G	0.75	19.05
H	0.650	16.51
J	2.75	69.85

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

AA CASE
WT 2LBS

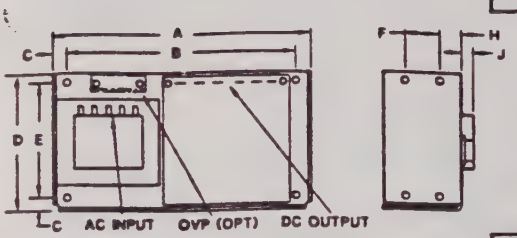


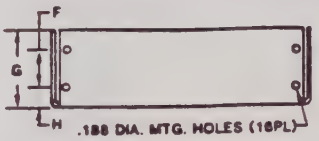
	INCH	mm
A	4.00	101.60
B	3.375	85.73
C	6.50	165.10
D	5.750	146.05
E	0.75	19.05
F	0.450	11.43
G	1.62	41.15
H	0.25	6.35
J	0.50	12.70
K	0.955	24.26
L	2.37	60.20
M	0.57	14.48

FUSE AT: 0.5/0.25 AMPS FOR 100-120/220-240 VAC

OUTLINE AND MOUNTING DRAWINGS (#12 SELF-TAPPING SCREWS MAY BE USED FOR MOUNTING UNITS)

CC CASE
WT. 7LBS.

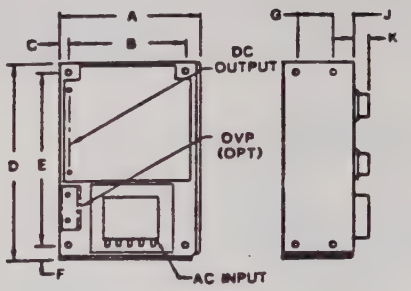


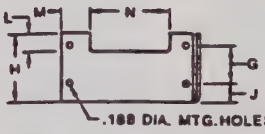


	INCH.	mm.
A	9.38	238.25
B	8.375	212.73
C	0.50	12.70
D	4.87	123.70
E	4.125	104.78
F	1.250	31.75
G	2.75	69.85
H	0.75	19.05
J	0.450	11.43

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC
HCC512: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

BB CASE
WT. 4LBS.

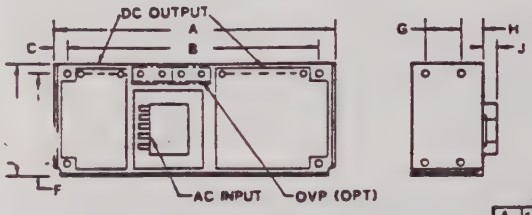


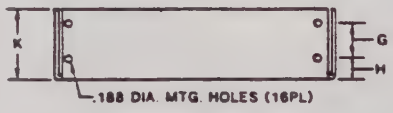


	INCH	mm
A	4.87	123.70
B	4.125	104.78
C	0.25	6.35
D	7.00	177.80
E	6.250	158.75
F	0.50	12.70
G	1.250	31.75
H	2.50	63.5
J	0.75	19.0
K	0.450	11.43
L	0.665	16.89
M	1.025	26.04
N	2.85	72.39

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

BAA CASE
WT. 5LBS.

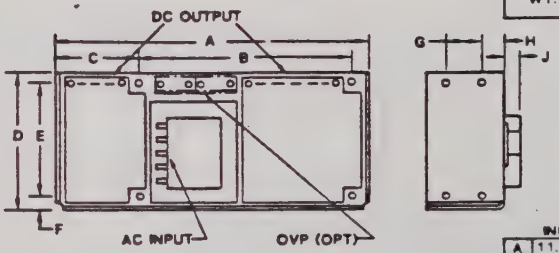


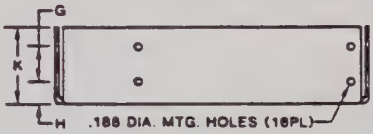


	INCH.	mm.
A	10.25	260.35
B	9.250	234.95
C	0.50	12.70
D	4.00	101.60
E	3.375	85.73
F	0.37	9.40
G	1.250	31.75
H	0.75	19.05
J	0.450	11.43
K	2.50	63.50

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

CBB CASE
WT. 8LBS.

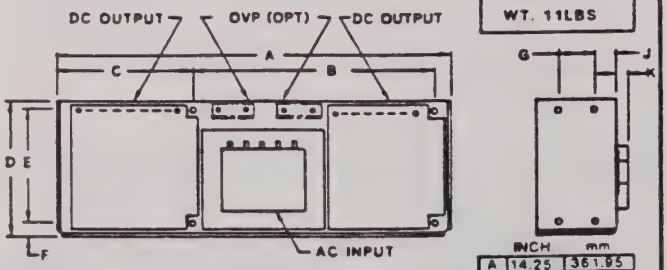


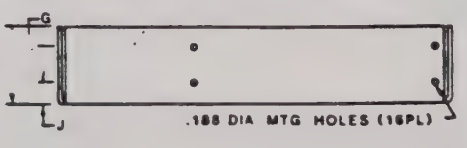


	INCH	mm
A	11.00	279.40
B	7.500	190.50
C	3.00	76.20
D	4.87	123.70
E	4.125	104.78
F	0.50	12.70
G	1.250	31.75
H	0.75	19.05
J	0.450	11.43
K	2.75	69.85

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC

DBB CASE
WT. 11LBS.

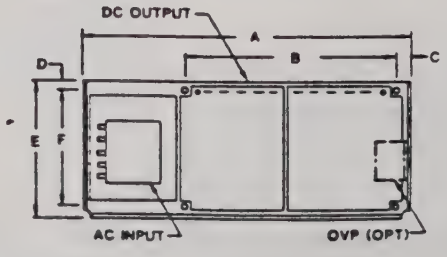


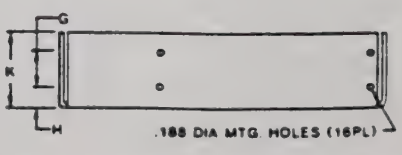


	INCH	mm
A	14.25	361.95
B	8.750	222.25
C	5.00	127.00
D	4.87	123.70
E	4.125	104.78
F	0.50	12.70
G	1.250	31.75
H	2.75	69.85
J	0.75	19.05
K	0.625	15.88

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

131 CASE
WT 9LBS





	INCH	mm
A	11.00	279.40
B	7.000	177.80
C	0.50	12.70
D	0.25	6.35
E	4.87	123.70
F	4.125	104.78
G	1.250	31.75
H	0.75	19.05
J	0.450	11.43
K	2.75	69.85
L	0.600	15.24
M	0.640	16.26
N	3.35	85.09

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

DWG NO.	REV
A 07788	A

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION		DATE	CHK	APPR
A	RELEASED E.O. #11965	BJ	5-13-83	CC	BJ
5	REVISED	BJ	1-25-83	RL	
4	REVISED PRELIMINARY	BJ	7-29-82		
3	REVISED PRELIMINARY	BJ	5-82		
2	REVISED	EA	11-81		
1	PRELINARY	EM	11-81		

REVISION LEVEL

A 10373

NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
PLUMBING KIT CONTROLLER 2000C
ANALOG FLOWMETERS
HARD PLUMBING

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	07788	A		

DRAWN	DATE	SHEET
B.J.	5/12/82	SHEET 1 OF 1

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	FLOWRATOR MOUNTING BRACKET	B 04118	6
	A/C FILTERS	06555	4
	COVER	07719	1
	INSULATED CRIMP CONNECTOR FEMALE	2120-5077	8
	STANDOFF 6-32 X 1.625	2860-8259	12
	FLOWRATER S.S.	2900-0375	3
	VALVE SOLENOID 120 V	5930-0002	4
	VALVE SOLENOID 120 V	5935-0025	1
	TUBING, SS 1/4 DIA.		AR
	BULKHEAD RETAINER 1/4 TUBE	5970-0024	8
	FITTING, BRASS 1/4 T x 1/8 NPT MALE	5970-0310	2
	FITTING, BRASS, BH 1/4 T X 1/8 NPT MALE	5970-0450	1
	FITTING, BRASS BHU 1/4 T X 1/4 T	5970-0903	2
	FITTING SS ELBOW 1/8 NPT x 1/4 T	5975-0036	1
	FITTINGS, SS TEE 1/4 T	5975-0052	3
	FITTINGS, SS 1/4 T X 1/8 NPT	5975-0038	4
	FITTINGS, SS BH 1/4 T X 1/4 T	5975-0037	5
	FITTINGS, SS HEX NIPPLE 1/8 NPT	5975-0071	3
	ADAPTOR SS TUBE END 1/8 NPTM 1/4 T	5975-0105	3
	FOLLOWING PARTS GO INTO REACTOR CENTER		
	BELLOWS 1" SS	B 04616	1
	BELLOWS 3/8" SS	B 04599	2
	FITTING BHU SS 3/8 T X 3/8 T	5975-0005	1
	FITTING BHL SS BHL SS 3/8 T X 1/4 NPT FEMALE	5975-0022	1
	FITTING CN SS 1/4 T X 1/4 NPT MALE	5975-0023	1
	BULKHEAD RETAINER 3/8 T	5970-0025	2
	CAP SS 3/8 T	5975-0062	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

PLUMBING KIT 2000C
ANALOG FLOWMETERS
HARD PLUMBING

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	07788	A		

DRAWN	DATE	SHEET
B.J.	5/11/82	1 OF 1

REV	A
DWG NO.	A 07775

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION		DATE	CHK	APPR
A	RELEASED E.O. #11965	BJ	5-13-83	CC	BT
2	REVISED PRELIMINARY	BJ	3-8-83		
1	PRELIMINARY	BJ	4-82		

REVISION LEVEL

NEXT ASSY.
A 07773
A 10485
E 10452

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07775	A		

DRAWN	DATE
B. J.	5/12/82

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
3	HEATSINK	B 04485	1
2	REGULATOR BOARD	C 06512	1
	SCHEMATIC	C 10454	REF
C406	CAPACITOR, CERAMIC DISC, .01 uF 500 V	1500-0001	1
C405, 409, 410, 411	CAPACITOR, 22 uF 16 V	1500-0011	4
C404, 407	CAPACITOR, CERAMIC DISC, .1 uF 25 V	1500-0026	2
C408, C401	CAPACITOR, CERAMIC DISC, .001 uF 1000 V	1500-0032	2
C402, 403	CAPACITOR, .05 uF 500 V	1500-0210	2
L401,402 403, 404	CHOKE, 39 uH	1800-0012	4
1	IC SOCKET 14 PIN	2110-0001	2
K401	RELAY, DIP REED	4500-0177	1
R410,	RESISTOR, CARBON 1K 1/4 W	4702-0102	1
R401, 403	RESISTOR, CARBON 10K 1/4 W	4702-0103	2
R402	RESISTOR, CARBON 22K, 1/4W	4702-0223	1
R417	RESISTOR, CARBON 240 ohm 1 W	4704-0241	1
R406, 412	RESISTOR, CARBON 3.3 K 1/4 W	4702-0332	2
R404, 415	RESISTOR, CARBON 390K 1/4 W	4702-0395	2
R405, 411, 416	RESISTOR, CARBON 4.7K 1/4 W	4702-0472	3
R408, 409	RESISTOR, CARBON 680 ohm 1/4 W	4702-0681	2
R414	POTENTIOMETER 1K	4750-0021	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07775	A		

DRAWN	DATE	SHEET
B.J.	5/12/82	2 OF 3

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
A401, 402	OPERATIONAL AMPLIFIER	4800-0012	2
Q401	TRANSISTOR - 2N 5657 - MOTOROLA	4800-0024	1
Q402	TRANSISTOR - 2N4921 - MOTOROLA	4800-0047	1
CR 417	DIODE	4800-0045	1
T401	AUDIO TRANSFORMER	5600-0014	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07775	A		

DRAWN	DATE	SHEET
B.J.	5/12/82	3OF 3

REV	C
DWG NO.	E 07690

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION			DATE	CHK	APPR
C	E.O. #12363	11-30-83	KL	12.01.83		
B	E.O. #12213	10-14-83	KL	10.18.83		
A	REVISED RELEASED E.O. #11965		BJ	5-13-83	CC	
8	REVISED		BJ	3-1-83		
7	REVISED		BJ	1-20-83		
6	REVISED PRELIMINARY		BJ	12-82		
5	REVISED PRELIMINARY		BJ	7-82		
4	REVISED PRELIMINARY		BJ	5-82		
3	REVISED PRELIMINARY		EA	11-81		
2	REVISED PRELIMINARY		EA	11-81		
1	PRELIMINARY		EM	10-81		

REVISION LEVEL

A 10373

NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

ASSEMBLY, CONTROLLER 2000C
WITH ANALOG FLOWMETERS

SIZE	DWG. NO.	REV.	CHK.	APPR.
E	07690	C		

DRAWN	DATE
B.J.	5-12-82

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	PLASTIC WINDOW	C 00972	1
	PCB 906 MOTHER	D 02884	1
	PCB 906 THUMBWHEEL	C 02888	1
	PCB 906 DISPLAY	C 02892	1
	METER BRACKET	B 04356	2
	REAR PANEL	D 10476	1
	CHASSIS PAN	D 07718	1
	GUSSET	C 07723	4
	GROUND BUSS	B 07727	1
	AC POWER SUPPLY CHASSIS	D 07729	1
	FAN MOUNTING BRACKET	B 07730	1
	AC POWER COVER TOP	C 07732	1
	VOLTAGE REGULATOR BOARD	C 07772	1
	AC POWER COVER BOTTOM	C 07784	1
	FRONT PANEL	D 07789	1
	DECAL	D 07790	1
	WIRING HARNESS D/C	E 10386	1
	WIRING HARNESS A/C	E 10387	1
	SCHEMATIC WITH TEMP. & CAPACITANCE MANOMETER	E 10436	REF
	SCHEMATIC WITH TEMP. & TC GAUGE	E 10437	REF
	CAPACITOR .1uf 400V	1500-0025	5
	CONNECTOR PCB 36 PIN, 906	2100-0002	2
	SOCKET, 8 PIN, RELAY PLUG	2110-0018	5
	CONNECTOR PCB EDGE 10 PIN	2100-0001	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

ASSEMBLY, CONTROLLER 2000C
WITH ANALOG FLOWMETERS

SIZE	DWG. NO.	REV.	CHK.	APPR.
E	07690	C		

DRAWN	DATE	SHEET
B.J.	5-11-82	3 OF 5

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	CONNECTOR 19 PIN FEMALE PANEL	2152-2212	1
	CONNECTOR 14 PIN MALE	2152-2215	1
	CONNECTOR 9 PIN FEMALE	2152-2220	1
	TERMINAL STRIP 10 PIN	2170-0003	1
	TERMINAL STRIP, 5 PIN	2170-0223	1
	MARKER 5 PIN	2170-0224	2
	TERMINAL STRIP JUMPER	2170-0235	6
	MARKER 10 PIN	2170-0004	2
	AUDIO ALARM	2200-0001	1
	KNOB	2400-0001	3
	FAN	2600-0182	1
	LINE FILTER 10 AMP	2700-0004	1
	CABINET BUMPERS	2800-0189	4
	TERMINAL STRIP	2860-0866	5
	STANDOFFS 6/32 x 1-3/8	2860-8257	12
	STANDOFF, CERAMIC	2860-2646	2
	LAMP, NEON AMBER 115V	3900-0001	8
	LAMP, NEON RED 115V	3900-0002	1
	SOCKET, LAMP	3900-0005	12
	CLIP, LAMP	3900-0006	12
	WASHER, LAMP	3900-0007	12
	LED AMBER 5V	3900-0101	3
	POWER SUPPLY	4000-0027	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

ASSEMBLY, CONTROLLER 2300C
WITH ANALOG FLOWMETERS

SIZE	DWG. NO.	REV	CHK.	APPR.
E	07690	C		

DRAWN	DATE	SHEET
B.J.	5-11-82	4 OF 5

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	RELAY, 120V DPDT TIME DELAY	4500-0159	3
	RELAY, 24 VAC DPDT 2 AMP	4500-0164	1
	RELAY, 28 VDC DPDT 10 AMP	4500-0170	1
	RESISTOR 100 ohm, 1W	4704-0101	5
	POTS 100K 2W	4750-0001	3
	SWITCH PUSHBUTTON WHITE CAP	5100-0002	2
	SWITCH DPDT BAT HANDLE RED CAP	5100-0004	2
	SWITCH DP 3 POSITION	5100-0012	2
	SWITCH 3PDT	5100-0013	1
	MICROSWITCH	5100-0017	1
	SWITCH SPDT BAT HANDLE	5100-0027	9
	SWITCH PUSH BUTTON DPDT WHITE CAP	5100-0035	1
	FUSE 3A	5150-0421	1
	FUSE HOLDER	5150-2516	1
	TRANSFORMER 24V	5600-0006	1
	LABEL PATENT	6100-0011	1
	LABEL APPROVED GASES	6100-0018	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
ASSEMBLY, CONTROLLER
WITH ANALOG FLOWMETERS

SIZE	DWG. NO.	REV.	CHK.	APPR.
E	07690	C		

DRAWN	DATE	SHEET
B.J.	5-11-82	5 OF 5

REV	B
DWG NO.	A 07772

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION		DATE	CHK	APPR
B	E.O. #12216	10-18-83 KG	10.26.83		
A	RELEASED E.O. #11965	BJ	5-13-83		
4	REVISED	BJ	4-13-83		
3	REVISED	BJ	2-28-83		
2	REVISED PRELIMINARY	BJ	1-31-83		
1	PRELIMINARY	BJ	4-19-82		

REVISION LEVEL

E 10452
E 07690
E 10462
E 10453
NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
VOLTAGE REGULATOR BOARD

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	07772	B		

DRAWN	DATE
B.J.	4-19-82

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	HEATSINK	04485	2
2	± 12V REGULATOR BOARD	B 12086	1
	SCHEMATIC	C 07785	REF
C1,C2	CAPACITOR 22 uf 16V	1500-0011	2
C3,C4	CAPACITOR .1 uf 20V	1500-0026	2
3	VECTOR BOARD TERMINALS	2160-0001	11
R1,R2	RESISTOR 33K, 1/4W, 5%	4702-0333	2
R3,R4	POTENTIOMETER 10K	4750-0013	2
VR1	VOLTAGE REGULATOR 7812	4800-0221	1
VR2	VOLTAGE REGULATOR 7912	4800-0223	1
	SCREW, NYLON, 4-40 x 1/2" L		2
	NUT, NYLON, 4-40		2
	#4 FIBER WASHER		2

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: ASSEMBLY, ± 12 V REGULATOR BOARD

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	07772	B		

DRAWN	DATE	SHEET
B. J.	4-19-82	2 OF 2

REV	E
DWG NO.	07775-XX

BRANSON INTERNATIONAL PLASMA CORPORATION
ENGINEERING PARTS LIST

07775-02	NEW VERSION
07775	OBSOLETE
PART Nº	DESCRIPTION

REV	DESCRIPTION		DATE	CHK	APPR
E	E.O.#653 R404, R415 - P/N: WAS - 4702-0395 IS - 4702-0394 ITEM		12.14.84		
D	REWORK ALL TO -02 LEVEL ADD DIODE CR420, MAKE NEW EO -02 VERSION 583 CKS		10-23-84 10.24.84		
C	PWA REMOVED E.O. #473		7.21.84		
B	PWA ADDED, R417 WAS 240 ohm EO#291		5.21.84		
A	RELEASED E.O. #11965	BJ	5-13-83	CC	
2	REVISED PRELIMINARY	BJ	3-8-83		
1	PRELIMINARY	BJ	4-82		

REVISION LEVEL

NEXT ASSY.
A 07773
A 10485
E 10452

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07775-XX	E		
DRAWN: B. J.	DATE: 5/12/82			

ENGINEERING PARTS LIST -02

REF. NO.	DESCRIPTION	PART NO.	QTY.
3	HEATSINK	B 04485	1
2	REGULATOR BOARD	C 06512	1
	SCHEMATIC	C 10454	REF
C406	CAPACITOR, CERAMIC DISC, .01 uF 500 V	1500-0001	1
C405, 409, 410, 411	CAPACITOR, 22 uF 16 V	1500-0011	4
C404, 407	CAPACITOR, CERAMIC DISC, .1 uF 25 V	1500-0026	2
C408, C401	CAPACITOR, CERAMIC DISC, .001 uF 1000 V	1500-0032	2
C402, 403	CAPACITOR, .05 uF 500 V	1500-0210	2
L401,402 403, 404	CHOKE, 39 uH	1800-0012	4
1	IC SOCKET 14 PIN	2110-0001	2
K401	RELAY, DIP REED	4500-0177	1
R410,	RESISTOR, CARBON 1K 1/4 W	4702-0102	1
R401, 403	RESISTOR, CARBON 10K 1/4 W	4702-0103	2
R402	RESISTOR, CARBON 22K, 1/4W	4702-0223	1
R417	RESISTOR, CARBON 240 ohm 1 W	4704-0241	1
R406, 412	RESISTOR, CARBON 3.3 K 1/4 W	4702-0332	2
R404, 415	RESISTOR, CARBON 390K 1/4 W	4702-0394	2
R405, 411, 416	RESISTOR, CARBON 4.7K 1/4 W	4702-0472	3
R408, 409	RESISTOR, CARBON 680 ohm 1/4 W	4702-0681	2
R414	POTENTIOMETER 1K	4750-0021	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO	REV.	CHK.	APPR.
D	07775-XX	E		

DRAWN	DATE	SHEET
B.J.	5/12/82	2 OF 3

ENGINEERING PARTS LIST -02

REF. NO.	DESCRIPTION	PART NO.	QTY.
A401, 402	OPERATIONAL AMPLIFIER	4800-0012	2
Q401	TRANSISTOR - 2N 5657 - MOTOROLA	4800-0024	1
Q402	TRANSISTOR - 2N4921 - MOTOROLA	4800-0047	1
CR 417	DIODE	4800-0045	1
CR 418,419	DIODE ZENER IN5245	4800-1031	2
CR420	DIODE, ZENER IN4742A 12V, 1W	4800-0053	1
T401	AUDIO TRANSFORMER	5600-0014	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: VACUUM METER AND CONTROL BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	87775-XX	E		

DRAWN	DATE	SHEET
B.J.	5/12/82	3 OF 3

A04289 REV B

REV	A
DWG NO.	A10384

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

A	REVISED RELEASED E.O. #11965	BJ	5-13-83	CC	
3	REVISED	BJ	3-1-83		
2	REVISED PRELIMINARY	BJ	7-29-82		
1	PRELIMINARY	BJ	4-82		
REV	DESCRIPTION		DATE	CHK	APPR

REVISION LEVEL

A 10373
NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
TEMPERATURE CONTROLLER KIT
COMPACT REACTOR CENTER

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10384	A		

DRAWN	DATE
B. J.	4-19-82

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	PLASTIC WINDOW	C 00972	1
	SCHEMATIC DIAGRAM	D 02905	REF
	921 MOTHER BOARD	D 02908	1
	921 DISPLAY BOARD	C 02912	1
	921 THUMBWHEEL BOARD	C 02916	1
	TEMPERATURE PROBE	C 02973	1
	PROBE MOUNTING BRACKET	B 03020	1
	PROBE MOUNTING CLAMP	B 04429	1
	PROBE SHEATH	C 04452	1
	MOUNTING BRACKET PCB	B 07712	2
	MOUNTING BRACKET FOOT	B 07713	2
	MOUNTING BRACKET ANGLE	C 07714	2
	HARNESS DC	C 10389	1
	STANDOFFS 6-32 x 1.250	2860-6324	4
	STANDOFFS 6-32 x .500	2860-8241	2
	STANDOFFS 6-32 x 1.375	2860-8257	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

COMPACT R/C
TEMPERATURE CONTROLLER KIT

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10384	A		

DRAWN	DATE	SHEET
B. J.	2-28-83	1OF 1

REV	L
DWG NO.	D 02908

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

PART NO.	DESCRIPTION
02908-02	USE ON DOWNSIZE +
02908	USE REG VERSION

REV	DESCRIPTION	DATE	CHK	APPR
L	ADD -02 VERSION PER E.O. #510			
K	REVISED BY E.O. # 12090 PD	08-15-83		
J	REVISED PER E.O. #11404 JD	10-18-82		

REVISION LEVEL

NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: MOTHER BOARD ASSEMBLY
TEMPERATURE CONTROLLER

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	02908	L		

DRAWN	DATE
J.B.	11-27-78

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY -	QTY 02
1	P.C. BOARD BLANK	D 02906	1	1
C101,102 C104,109 C111,112 C115-119	CAPACITOR, DC, 500V, .01mFd, SPRAGUE #5GAS-S10	1500-0001	11	11
C120	CAPACITOR, 18 mF, SIEMENS #B0320541-011851250	1500-0006	1	1
C107,108 C110	CAPACITOR, .1mF, 400V FOIL +10%, SPRAGUE #4PS-P10	1500-0025	3	3
C121	CAPACITOR, .1mF 20V, CENTRALAB #UK20-104	1500-0026	1	1
C106	CAPACITOR, .001 mF, 1 KVDC, SPRAGUE #5GA-D10	1500-0032	1	1
C113,114	CAPACITOR, ELECT. 2000mF 25VDC, SPRAGUE #TVA-1213	1500-0208	2	0
C103	CAPACITOR, .47mF 200VDC FOIL +10%, SPRAGUE #2PS-P47	1500-0211	1	1
C105	CAPACITOR, .02mF 500VDC, SPRAGUE #5GAS-S20	1500-0213	1	1
J201,202	P.C. EDGE CONNECTOR, CINCH JONES #50-36B-10	2100-0189	2	2
2	IC SOCKETS, 14 PIN, AMPHENOL #821-20011-144	2110-0001	23	23
3	IC SOCKETS, 16 PIN, AMPHENOL #821-20011-164	2110-0002	3	3
R107	RESISTOR, METAL FILM, 1-2%, 1/4W, 100 OHMS	4602-0101	1	1
R108	RESISTOR, METAL FILM, 1-2%, 1/4W, 1.2K OHMS	4602-0122	1	1
R128	RESISTOR, METAL FILM, 1-2%, 1/4W, 1.6K OHMS	4602-0162	1	1
R110	RESISTOR, METAL FILM, 1-2%, 1/4W, 30K OHMS	4602-0303	1	1
R112	RESISTOR, METAL FILM, 2%, 1/4W, 5.1K OHMS	4602-0512	1	1
R129,134	RESISTOR, CARBON COMP. 1/4W, 1K OHMS	4702-0102	2	2
R103,113	RESISTOR, CARBON COMP. 1/4W, 10K OHMS	4702-0103	2	2
R122,126 R127	RESISTOR, CARBON COMP. 1/4W, 200 OHMS	4702-0201	3	7
R104,115 R116,119 R120,124	RESISTOR, CARBON COMP. 1/4W, 2K OHMS	4702-0202	6	6
R125,131 R118,121	RESISTOR, CARBON COMP. 1/4W, 2.7K OHMS	4702-0272	4	4

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: MOTHER BOARD ASSEMBLY
TEMPERATURE CONTROLLER

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	02908	L		

DRAWN	DATE	SHEET
JB	11-17-78	2 OF 3

0

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY -	QTY 02
R102,114 R123,130	RESISTOR, CARBON COMP. 1/4W, 470 OHMS	4702-0471	4	4
R105,117 R133	RESISTOR, CARBON COMP. 1/4W, 5.6K OHMS	4702-0562	3	3
R132	RESISTOR, CARBON COMP, 1/2W, 22 OHMS	4703-0220	1	1
R111	POTENTIOMETER, 50K OHMS, BOURNES #3069P-1-503	4750-0012	1	1
R106	POTENTIOMETER, 10K OHMS, BOURNES #3069P-1-103	4750-0013	1	1
R109	POTENTIOMETER, 500 OHMS, BOURNES #3069P-1-501	4750-0966	1	1
U113,121	OPERATIONAL AMPLIFIER, FAIRCHILD #MA747	4800-0012	2	2
CR105	RECTIFIER BRIDGE, QUAD INT'L #18DB2A	4800-0044	1	0
CR101-103	DIODE, MOTOROLA #IN4151	4800-0045	3	3
Q101	TRANSISTOR, MOTOROLA #2N4918	4800-0046	1	1
Q102	TRANSISTOR, MOTOROLA #2N4921	4800-0047	1	1
U117,120 U125,126	2 INPUT NAND, TEXAS INSTRUMENTS #SN7400N	4800-0103	4	4
U101-103	2 INPUT NAND, OPEN CO., TEXAS INSTRUMENTS #SN7403N	4800-0104	3	3
U105,114 U115,124	J-K FLIP-FLOP, TEXAS INSTRUMENTS #SN74H103N	4800-0106	4	4
U106,107	BINARY COUNTERS/LATCHES, TEXAS INSTRUMENTS #SN74176N	4800-0107	2	2
U104,112 U118,123	HEX INVERTER, TEXAS INSTRUMENTS #SN7404N	4800-0114	4	4
U111	AN-OR-INVERT GATE, TEXAS INSTRUMENTS #SN74S64N	4800-0115	1	1
U116	BINARY COUNTERS/LATCHES, TEXAS INSTRUMENTS #SN74177N	4800-0116	1	1
U108-110	BI-STABLE LATCH, TEXAS INSTRUMENTS #SN7475N	4800-0117	3	3
U119	3 INPUT NAND, TEXAS INSTRUMENTS #SN7410N	4800-0118	1	1
U122	DUAL FET SWITCH, SILICONEX #DG200BP	4800-0120	1	1
T101	TRANSFORMER, SIGNAL #241-4-20	5600-0006	1	0
	SCHEMATIC, PM 921	D 02905	REF	
	SCHEMATIC, PM 923	D 04532	REF	

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: MOTHER BOARD ASSEMBLY
TEMPERATURE CONTROLLER

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	02908	L		JCD

DRAWN	DATE	SHEET
JB	11-27-78	3 OF 3

ENGINEERING PARTS LIST 0

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	P.C. CARD, BLANK	C 02910	1
2	IC SOCKET, 16 PIN	2110-0002	3
R201-221	RESISTOR, ¼ W 100 ohms	4702-0101	21
U201-203	BCD TO 7 SEGMENT DECODER/DRIVER	4800-0112	3
	TI #7447 A		
U204-206	7 SEGMENT DISPLAY .065 Hi	4800-0113	3
	LITRONIX #DL 747		

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE A-3 DISPLAY CARD
TEMPERATURE CONTROLLER

SIZE	DWG. NO.	REV.	CHK.	APPR.
B	02912	A	PY	PCO

DRAWN	DATE	SHEET 2 OF 2
SStock	7-13-78	

REV	D
DWG NO.	A 10372

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

10372
PART NUMBER

REV	DESCRIPTION		DATE	CHK	APPR
D	P/N D12164-02 WAS D07703 EO 757		11-85		
C	P/N 12253-01 ADDED / EO614				
B	750-12494-01 ADDED / EO 573		11/6/84		
A	REVISED RELEASED E.O. #11965	BJ	5-13-83	CC	
2	REVISED PRELIMINARY	BJ	2-1-83		
1	PRELIMINARY	BJ	4-82		

REVISION LEVEL

NEXT ASSY.
A 10373
A 10374
A 10375

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: 11020 REACTOR CENTER ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10372	D		

DRAWN	DATE
B. J.	4-19-82

A05495 REV. B

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	AC POWER CABLE	B 02349-005	1
	OUTLET FLANGE	B 02596	1
	SCREEN FAN	B 02799	2
	INDUCTOR, 6-1/2 TURNS	C 02824	1
	WINDOW STOP	A 03162	4
	DOOR TENSION SPRING	B 03752	2
	FOOT SUPPORT	B 03931	4
	ELECTRODE SUPPORT	B 03933	4
	HANGER BRACKET	B 03934	4
	RF SHIELD, DOOR	C12253-01	1
	SLIDE WINDOW TEFLON	C 04224	1
	BASE PLATE MTG BRACKET AUTOMATCH	B 04418	1
	BRACKET CAPACITOR MOUNTING	B 04426	2
	CUP JOINT EXHAUST GAS	B 10465	1
	INDUCTOR, 4-1/2 TURNS	C 04462	1
	INDUCTOR, 5-1/2 TURNS	C 04463	1
	WINDOW 10" REACTOR CENTER	C 04480	1
	TEFLON PAD	C 04625	1
	SHORTING PLUG	B 04340	1
	10" x 20" CHAMBER	E 05361	1
	ACORN NUT	B 05754	6
	PUMP HOOK UP KIT	A 06041	1
	CLAMP HOOK	B 06177	2
	BOLT MODIFIED	A 06523	1
	NUT MODIFIED	A 06524	1
	DOOR HANDLE MODIFIED	A 06525	1
	STRIKER RIGHT	B 06543	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

ASSEMBLY
11020 REACTOR CENTER

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10372	D		

DRAWN	DATE	SHEET
B. J.	4-19-82	1 OF 3

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	AUTOMATCH PM 702-A	D 07694	1
	FRONT PANEL	D 07697	1
	GUSSET WALL	C 07698	2
	DECK ASSEMBLY	E 07701	1
	DPS HOUSING REAR ANGLE	D 07702	1
	DOOR, RC 10" & 12", BLUE-BLACK	12164-02	1
	INSULATOR SUPPORT	B 07705	8
	DOOR HINGE	C 07706	1
	FOOT SUPPORT 45°	B 07707	4
	REAR PANEL	D 07708	1
	COVER	E 07720	1
	COVER STIFFENER REAR	C 07721	1
	SWITCH BLOCK	B 07722	1
	DPS HOUSING COVER	C 07725	1
	DOOR STOP	B 07731	1
	CONNECTOR PLATE ELECTRODE	D 07733	1
	CONDUIT	C 07726	2
	SUB CHASSIS COVER	B 09747	2
	MODESTY PLATE	C 09749	1
	REAR PANEL ACCESS	C 09750	1
	INNER DOOR PLATE	D 09751	1
	CHAMBER RETAINER 10" REACTOR	D 09752	1
	ELECTRODE ASSEMBLY 10"	D 09753	1
	SUB CHASSIS	D 09754	4
	GAS BALL QUARTZ	B 09755	1
	STRAP, RF CONDUCTOR	750-12494-01	1
	HORIZONTAL BAR	D 10427	2
	HOT ELECTRODE PLATE	D 10479	1
	SCHEMATIC 2000C	D 10455	REF
	SCHEMATIC 4000C and 3000C	D 10456	REF

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
ASSEMBLY
11020 REACTOR CENTER

SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10372	D		

DRAWN	DATE	SHEET
B. J.	4-19-82	2 OF 3

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	CAPACITOR TUBULAR 100 pf	1500-0189	4
	SOCKET MATE-N-LOK 24-18GA.	2120-0701	10
	CONNECTOR 9 PIN MALE	2152-2221	1
	CONNECTOR 19 PIN MALE	2152-2211	1
	TERMINAL STRIP 10 PIN	2170-0003	1
	MARKER	2170-0004	2
	CONNECTOR MATE-N-LOK 4 CIRCUIT	2180-0189	1
	CONNECTOR MATE-N-LOK 6 CIRCUIT	2180-0193	1
	FAN	2600-0004	1
	LINE FILTER	2700-0004	1
	LEVELLER SILENT	2800-0005	4
	1/2" CONDUIT CONNECTOR	2800-0086	4
	HOSE CLAMP	2800-0237	1
	STANDOFF HEX ALUM. 6-32 X 1-3/8"	2860-0020	19
	MICROSWITCH	5100-0017	2
	MAGNETIC CONTACT SET	5100-0255	2
	O-RING SIL 3/8"	5900-0012	4
	O-RING SIL 1"	5900-0120	3
	O-RING SIL 3/4"	5900-2116	3
	10" GASKET	5905-2452	1
	VALVE VACUUM PNEUMATIC	5935-0027	1
	CLAMP THOMAS	5950-0001	3
	CLAMP THOMAS	5950-0002	1
	CLAMP STAUFF	5950-0007	1
	FITTING BULKHEAD RETAINER 1/4	5970-0024	2
	FITTING BULKHEAD RETAINER 3/8"	5970-0025	2
	FITTING BULKHEAD 1/4 T x 1/4 T	5970-0903	2
	FITTING, BRASS ELBOW 1/4 T x 1/8 NPT	5970-1306	2
	CORD POWER	6000-0049	1
	LABEL	6100-0016	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
ASSEMBLY
11020 REACTOR CENTER

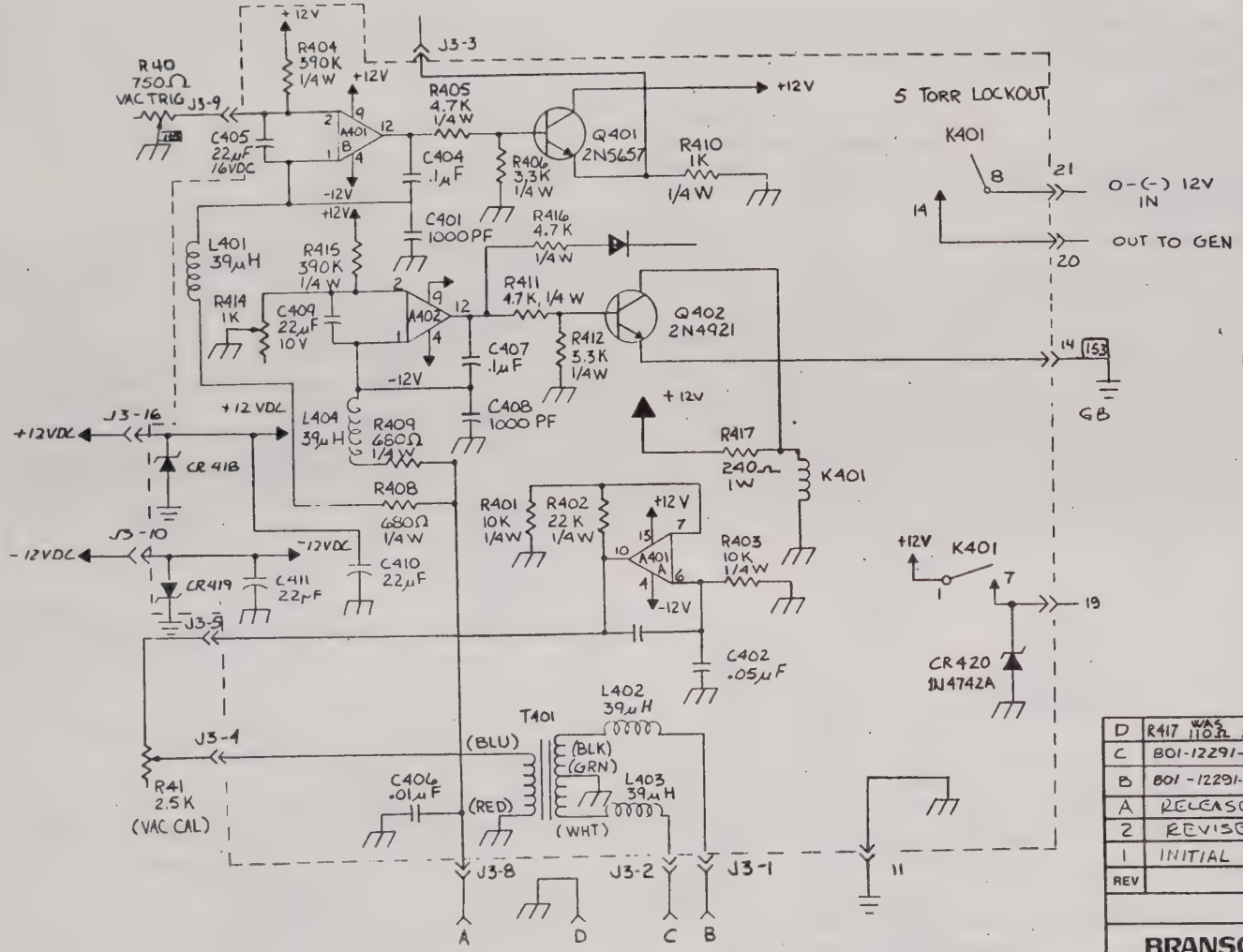
SIZE	DWG. NO.	REV.	CHK.	APPR.
A	10372	D		

DRAWN	DATE	SHEET
B. J.	4-19-82	3 OF 3

NOTE: (UNLESS OTHERWISE SPECIFIED)

MATERIAL LIST

NO.	DESCRIPTION	PART NO.	QTY.



REV	DESCRIPTION	DATE	CHK	APPR
D	R417 WAS 110Ω IS 240Ω ADD CR420 EO 583	10-31-84	[illegible]	[illegible]
C	B01-12291-01 REMOVED E.C.#473	9/2/84	[illegible]	[illegible]
B	B01-12291-01 ADDED EO#291	5/21/84	[illegible]	[illegible]
A	RELEASED EO#11965	5/83	CC	[illegible]
2	REVISED	4/83		
1	INITIAL ISSUE DL	5/83		

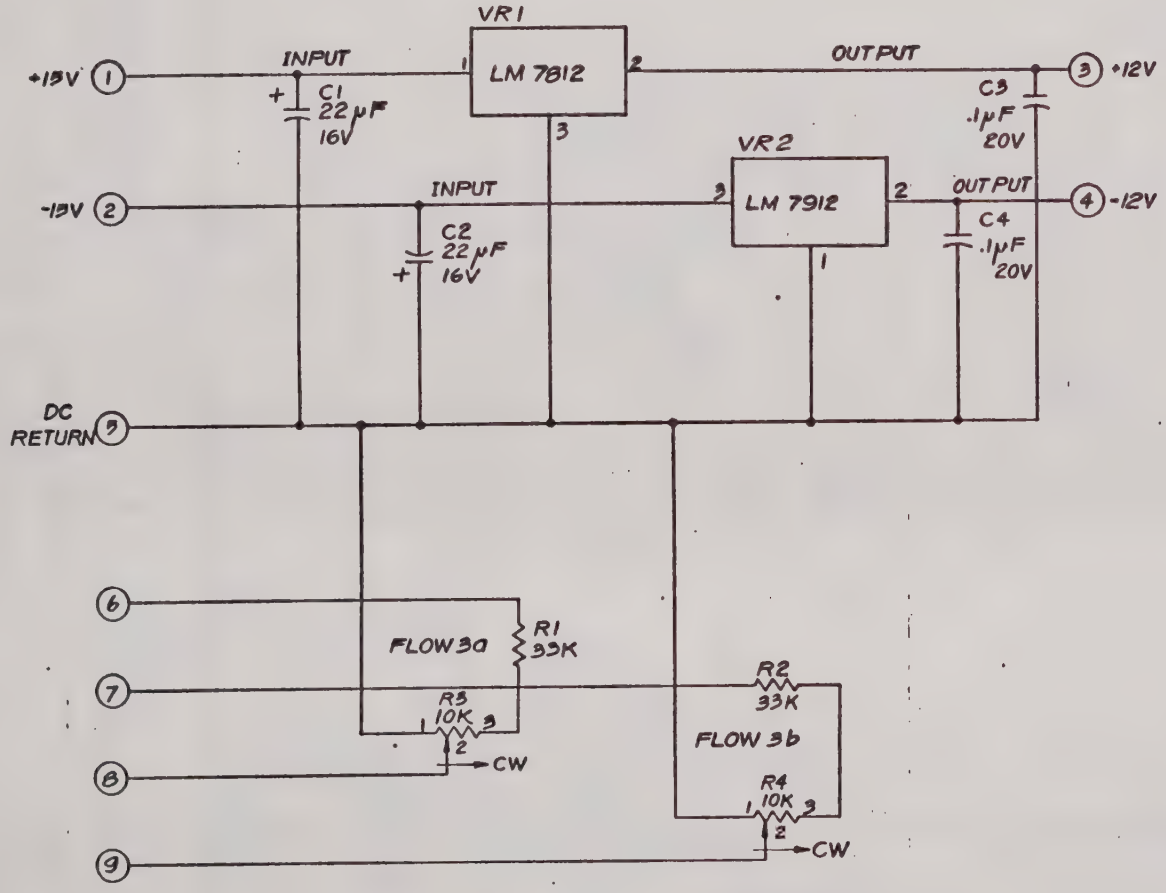
REVISION LEVEL

BRANSON/IPC
a SmithKline company

NEXT ASSY 407773	DFT D.LUCAS	DATE 5/26/83	TOLERANCES UNLESS OTHERWISE SPECIFIED .XX± mm ± SURF. FIN. √ .XXX± ANGLES ±
	CHK	DATE	TITLE VACUUM METER & CONTROL CIRCUIT OPTION
	ENG [illegible]	DATE 5/26/83	
MODEL	FINISH		SCALE — SIZE C — DRAWING NO. 10454 — SHT 1 OF 1 — REV D

NOTE: (UNLESS OTHERWISE SPECIFIED)
1. – RESISTANCES ARE IN OHMS, 1/4W, 5%
– CAPACITANCES ARE IN MICROFARADS.

MATERIAL LIST			
REF.NO.	DESCRIPTION	NO.	QTY.



(0-5 VOLT OUTPUT - ADJUST FOR MASS FLOW CONTROLLER MODEL ONLY)

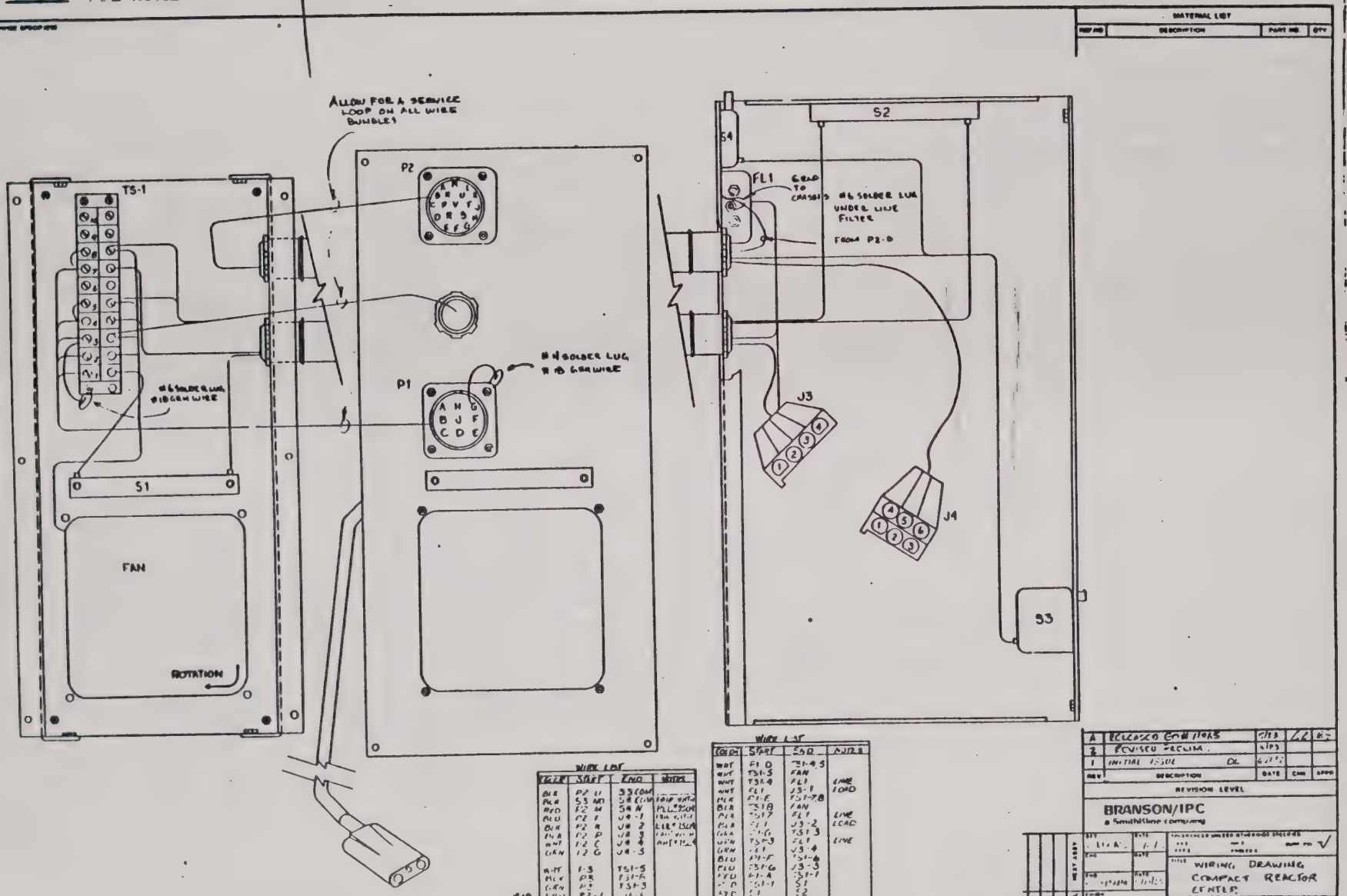
REV	DESCRIPTION	DATE	CHK	APPR
B	REVISED ECO # 12216	10-26-83		

REVISION LEVEL

BRANSON/IPC
a SmithKline company

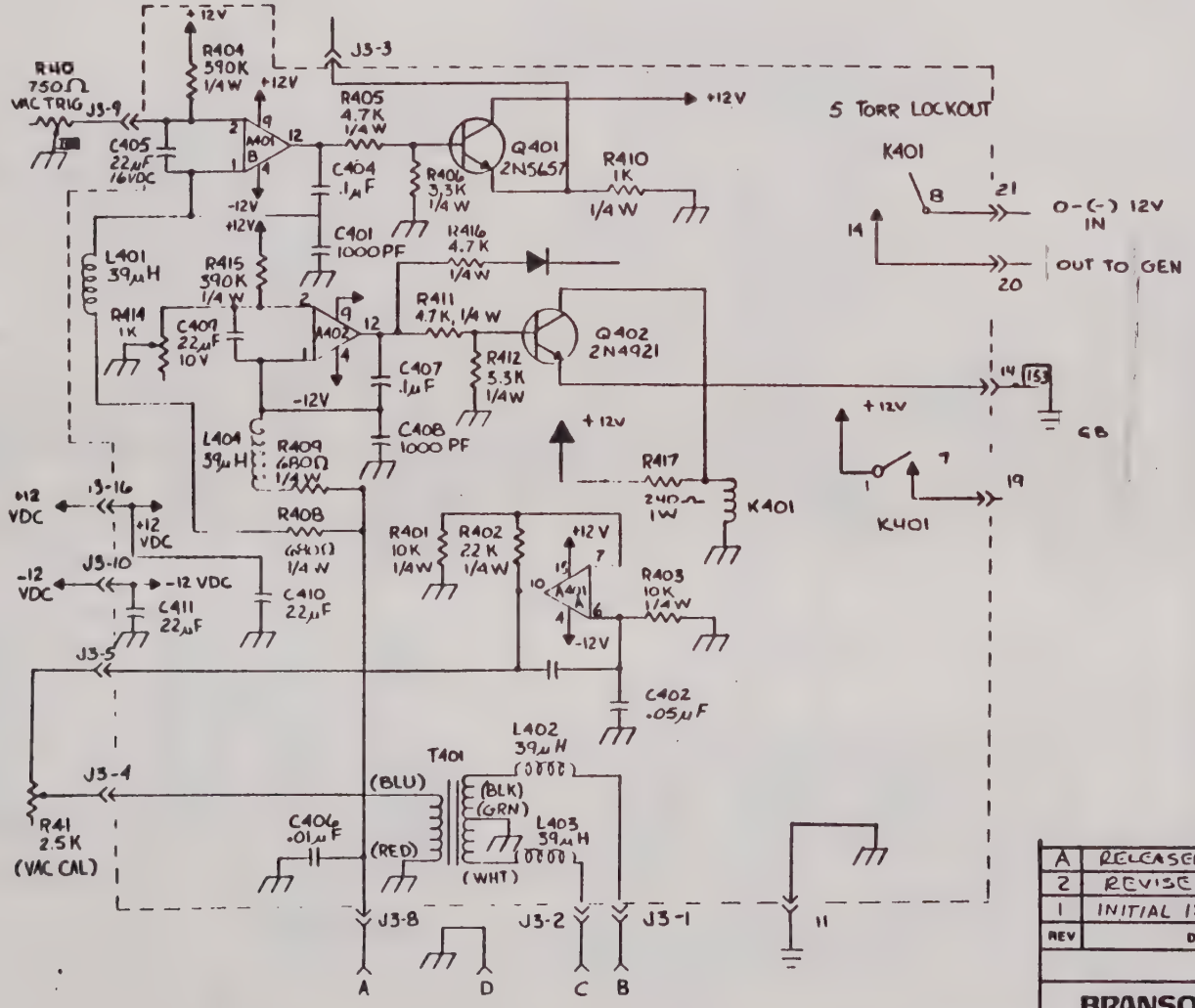
DFT K. La	DATE 10-17-83	TOLERANCES UNLESS OTHERWISE SPECIFIED .XX± ~ .XXX± ~ mm± ~ ANGLES± ~ SURF. FIN. √	
CHK	DATE	TITLE SCHEMATIC, ±12V REGULATOR	
ENG	DATE		
FINISH		SCALE ~ SIZE C DRAWING NO. 07785 SHT / OF 1/1 REV B	

MODEL 007772 NEXT ASSY


ALLOW FOR A SERVICE LOOP ON ALL WIRE BUNDLES
TS-1
P2
P1
S1
S2
S3
S4
FAN
ROTATION
FL1
GND TO CHASSIS
#6 SOLDER LUG UNDER LINE FILTER
FROM P2-D
#6 SOLDER LUG #18 GRN WIRE
#6 SOLDER LUG #18 GRN WIRE
J3
J4
MATERIAL LIST
WIRE LIST
WIRE LIST
BRANSON/IPC
a Smithkline company
WIRING DRAWING
COMPACT REACTOR
CENTER
REVISION LEVEL
INITIAL ISSUE
DESCRIPTION

NOTE: (UNLESS OTHERWISE SPECIFIED)

MATERIAL LIST			
REF.NO.	DESCRIPTION	NO.	QTY.

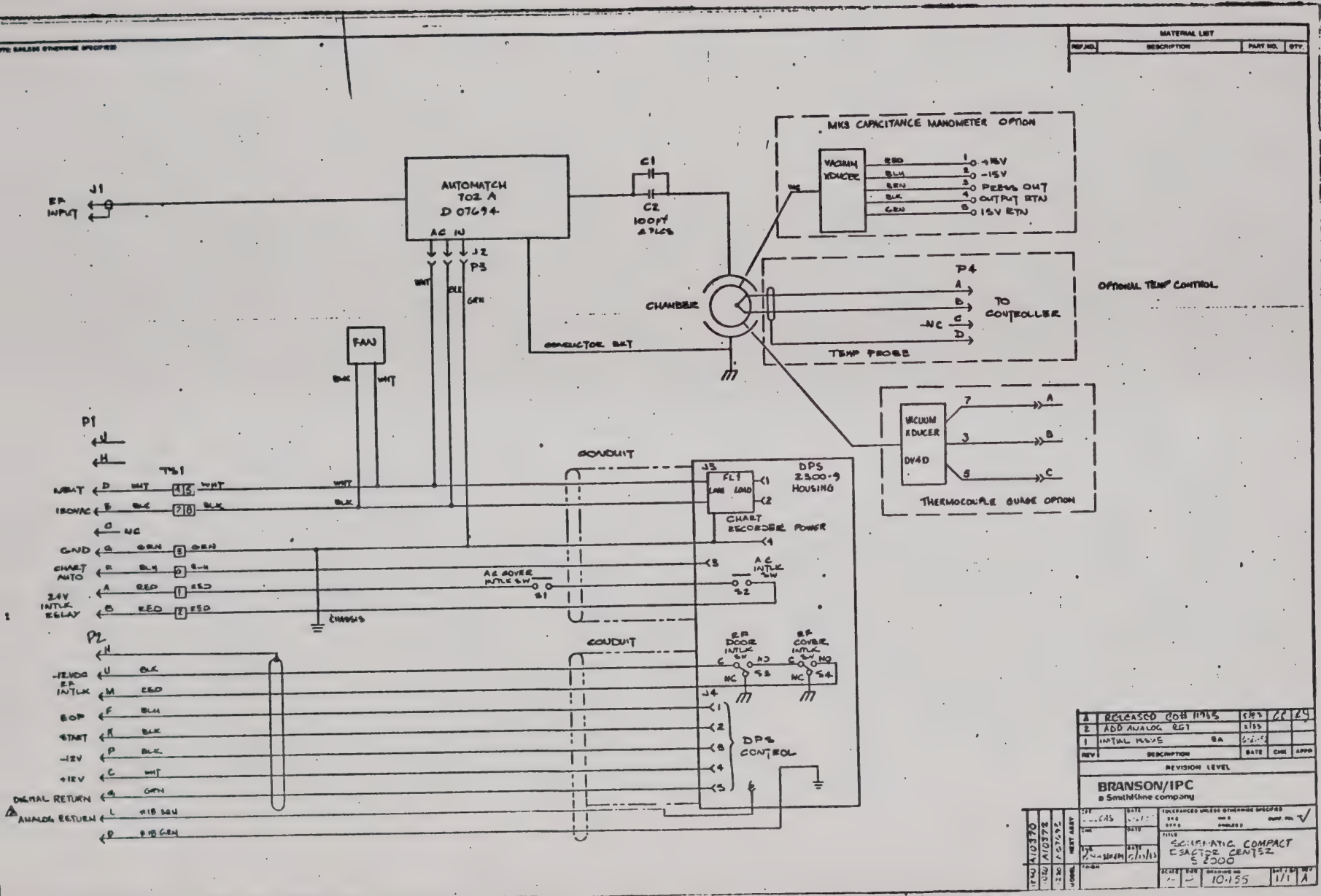


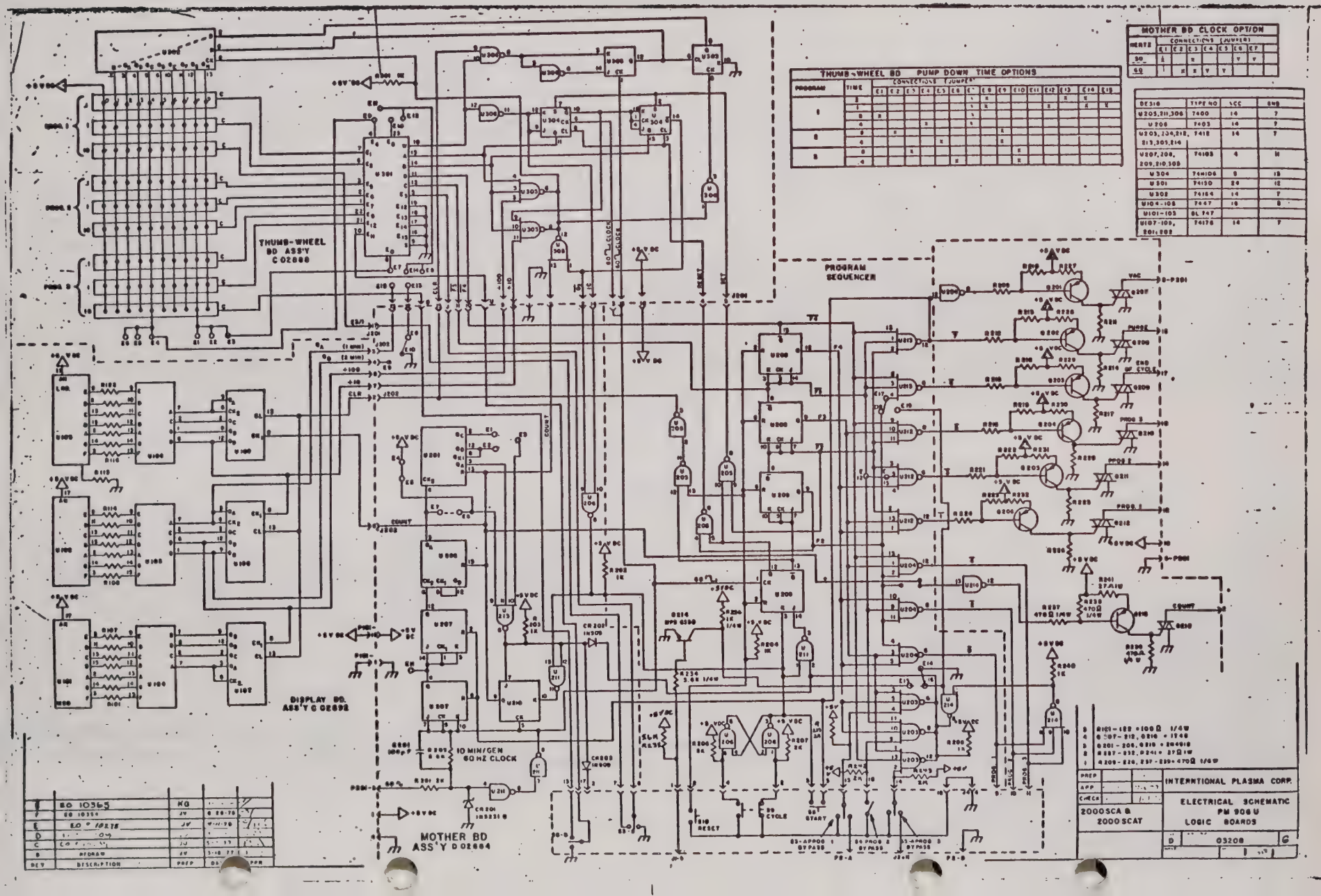
REV	DESCRIPTION	DATE	CHK	APPR
A	RELEASED EO # 11965	5/83	CC	BJ
2	REVISED	4/83		
1	INITIAL ISSUE DL	5/26/82		

REVISION LEVEL

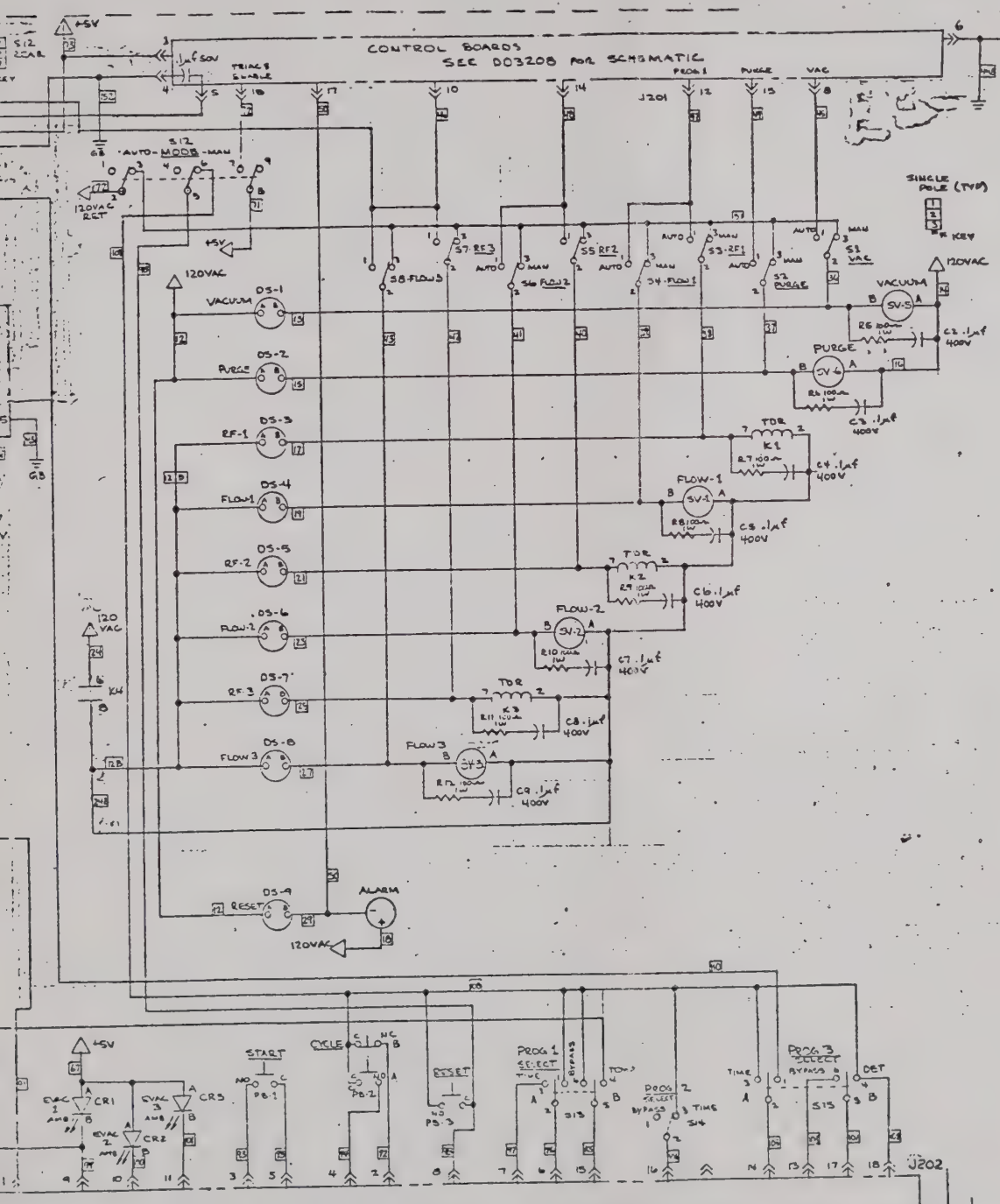
BRANSON/IPC
a SmithKline company

NEXT ASSY 45773	DFT D LUCAS 5/26/82	TOLERANCES UNLESS OTHERWISE SPECIFIED .XX ± .XXX ± mm ± ANGLES ± SURF. FIN. √	
	CHK	TITLE VACUUM METER & CONTROL CIRCUIT OPTION	
	ENG [illegible] DATE 6/1/82		
MODEL	FINISH	SCALE	SIZE C
		DRAWING NO. 10454	SHT 1 OF 1
			REV A


MATERIAL LIST
REF NO. | DESCRIPTION | PART NO. | QTY.
MKS CAPACITANCE MANOMETER OPTION
VACUUM XDUCER
+15V
-15V
PERKS OUT
OUTPUT RTN
15V RTN
J1
RF INPUT
AUTOMATCH 702 A D 07694-
AC IN
J2
P3
C1
C2
1000PF 4PLCS
CHAMBER
CONDUCTOR BAT
P4
TO CONTROLLER
-NC
TEMP PROBE
OPTIONAL TEMP CONTROL
FAN
BLK
WHT
P1
TB1
WHT
BLK
GND
GRN
CHART AUTO
RED
24V INTLK RELAY
CHASSIS
CONDUIT
J3
FLT
LINE LOAD
DPS 2300-9 HOUSING
CHART RECORDER POWER
AC COVER INTLK SW
S1
AC INTLK SW
S2
VACUUM XDUCER
DV4D
THERMOCOUPLE GUAGE OPTION
P2
-15VDC RF INTLK
BIAS
START
-12V
+12V
DIGITAL RETURN
ANALOG RETURN
#18 BLU
#18 GRN
RF DOOR INTLK SW
RF COVER INTLK SW
S3
S4
J4
DPS CONTROL
A RELEASED FOR MFG 5/83 LL LS
2 ADD ANALOG RET 4/83
1 INITIAL RELEASE BA 4/82
REV DESCRIPTION DATE CHK APPD
REVISION LEVEL
BRANSON/IPC
a SmithKline company
SCHEMATIC COMPACT REACTOR CENTER 2300
10-155
1/1
A


THUMB-WHEEL BD ASS'Y C 02888
DISPLAY BD. ASS'Y C 02892
MOTHER BD ASS'Y D 02884
PROGRAM SEQUENCER
10 MIN/GEN 60 HZ CLOCK
THUMB-WHEEL BD PUMP DOWN TIME OPTIONS
MOTHER BD CLOCK OPTION
INTERNTIONAL PLASMA CORP.
ELECTRICAL SCHEMATIC PM 906 U LOGIC BOARDS
2000SCA & 2000SCAT
03208

AC POWER ISOLATION BOX
REACTOR COVER INTLK
AC POWER TO REACTOR CENTER
ACCESSORY STRIP CHART RECORDER
DPS POWER TO REACTOR CENTER
J1
J2
INTLK AC POWER BOX COVER
DOUBLE POLE (TYP)
KEY
K5 24V
S11 AC POWER
T1
CHASSIS
120VAC
TB-2
TB-1
120VAC RET.
C1 .1 MFD
R4 180Ω
FROM R.F. GEN.
F2 3A
DC RETURN
LINE FILTER
K5
CHASSIS
RF POWER LEVEL CONTROL
PROG 1 RF
PROG 2 RF
PROG 3 RF
R1 100K
R2 100K
R3 100K
K1
K2
K3
S16 SCALE SELECT SWITCH
M4 RF POWER METER
0 to -12V
REFL
FWD
VACUUM METER & CONTROL CIRCUIT
SEE DWG # C10954
FOR SCHEMATIC
M1
K4 12V
+12V
750Ω R40 VAC TRIM
2.3K R41 VAC CAL
TEMPERATURE CONTROL BOARDS
SEE D02906 FOR SCHEMATIC
J101
J102
120 VAC
120 VAC RET
+5V
PUSH BUTTON
TEMP PROBE IN
J3
J4
VACUUM XDUCER
OPTIONAL TEMP PROGRAMMER
POWER SUPPLY
+5V
-15V
TWISTED PAIR



REV	DESCRIPTION	DATE	CHK	APPR
A	REVISED RELEASED TO MFG	12/31		
3	REV 3 PRELIM			
2	60 HZ CLA DL			
1	PRELIM	5/15		

REVISION LEVEL

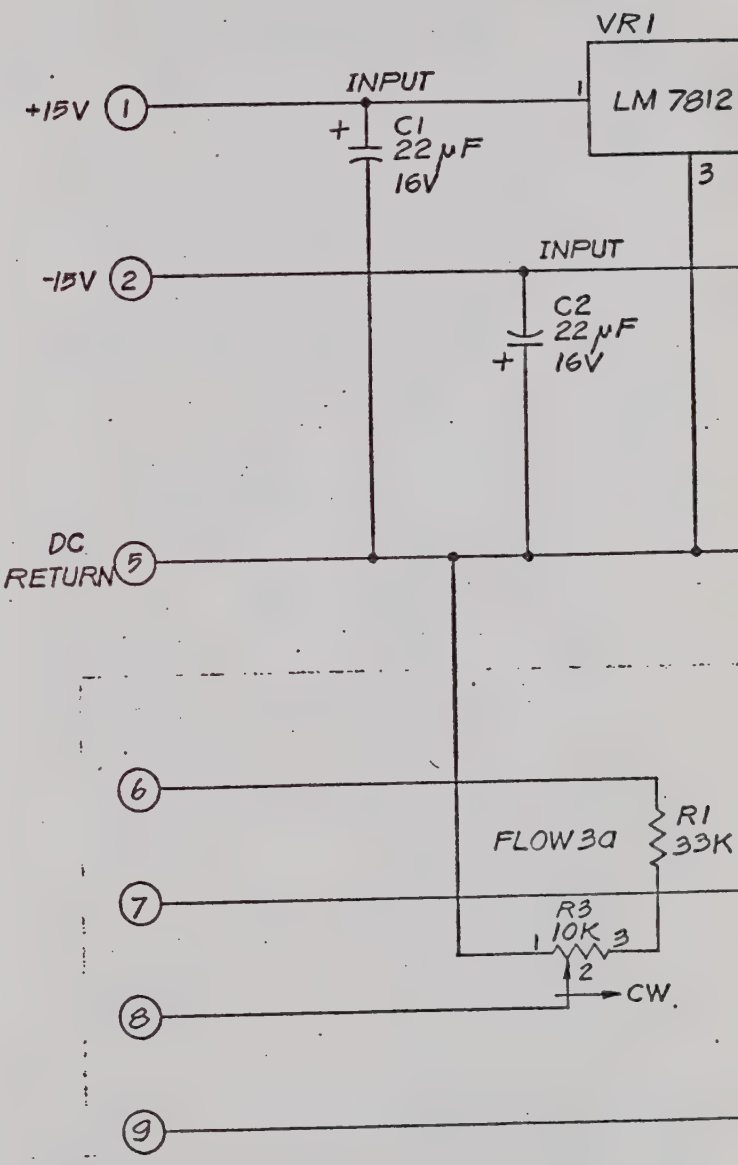
BRANSON/IPC
a Smithkline company

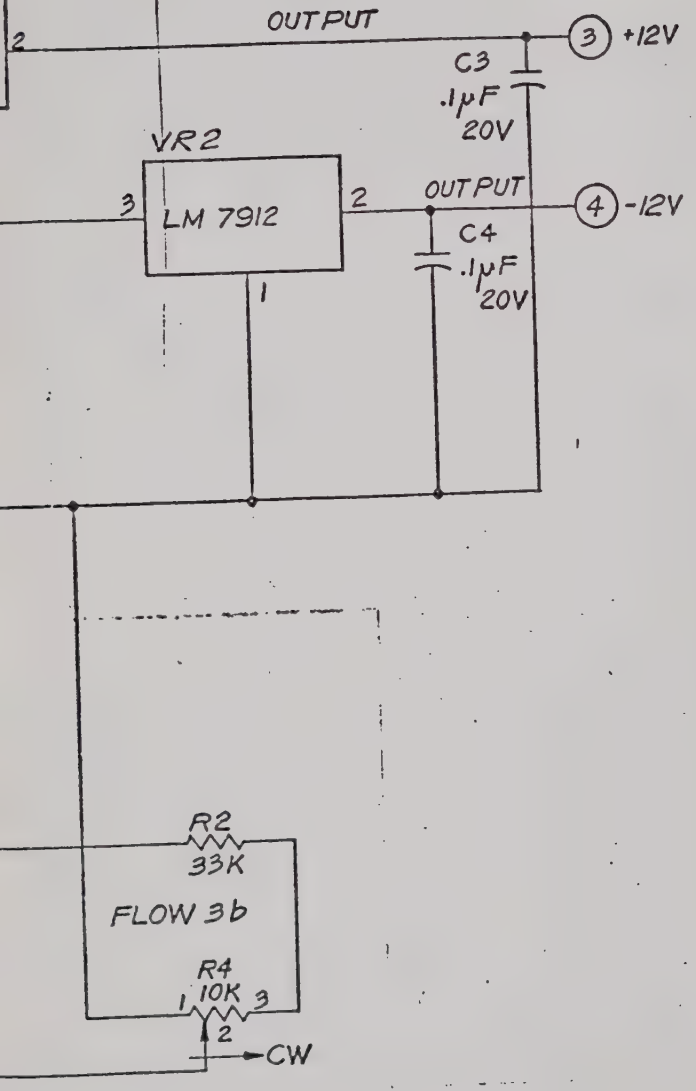
DRN	DOUGAS	5-7-85	TOLERANCES UNLESS OTHERWISE SPECIFIED .XX = ± .XXX = ± ANGLES = ±
CHK			DWG FOR
ENG		10/12	TITLE 2000C CONTROLLER W TC GAUGE VACUUM CIRCUIT
MFG			
QUAL			
APP		5/15/85	

C07670 NEXT ASSY
2000C MODEL
SCALE E
DWG NO 10437
SHT OF
REV A

NOTE: (UNLESS OTHERWISE SPECIFIED)

1. – RESISTORS ARE IN OHMS, 1/4 W, 5%
   – CAPACITORS ARE IN MICROFARADS.





(0-5 VOLT OUTPUT - ADJUST FOR MASS FLOW CONTROLLER MODEL ONLY)

MATERIAL LIST

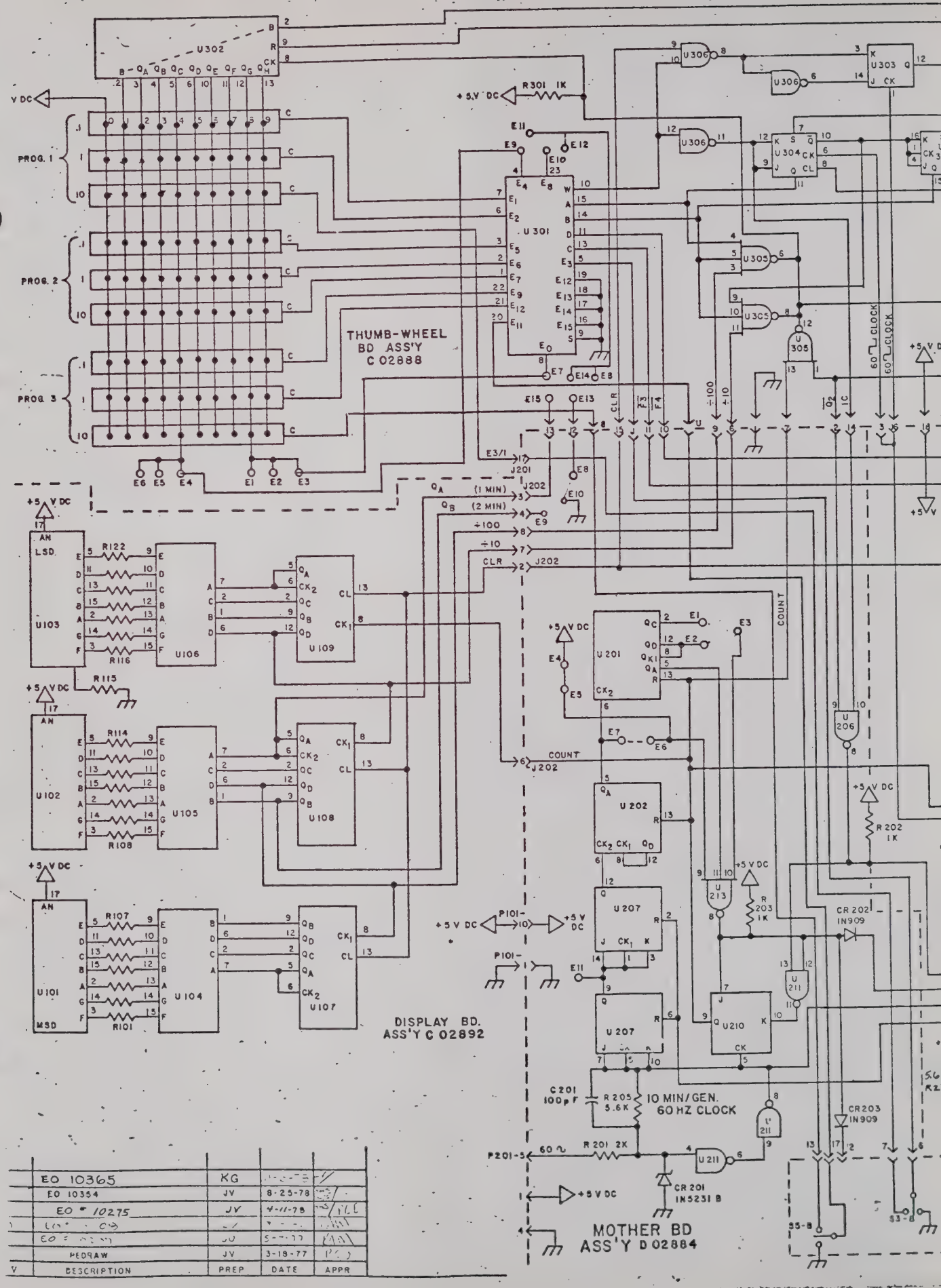
REF.NO.	DESCRIPTION	PART NO.	QTY.

REV	DESCRIPTION	DATE	CHK	APPR
B	REVISED E.O # 12216	10-2-13		

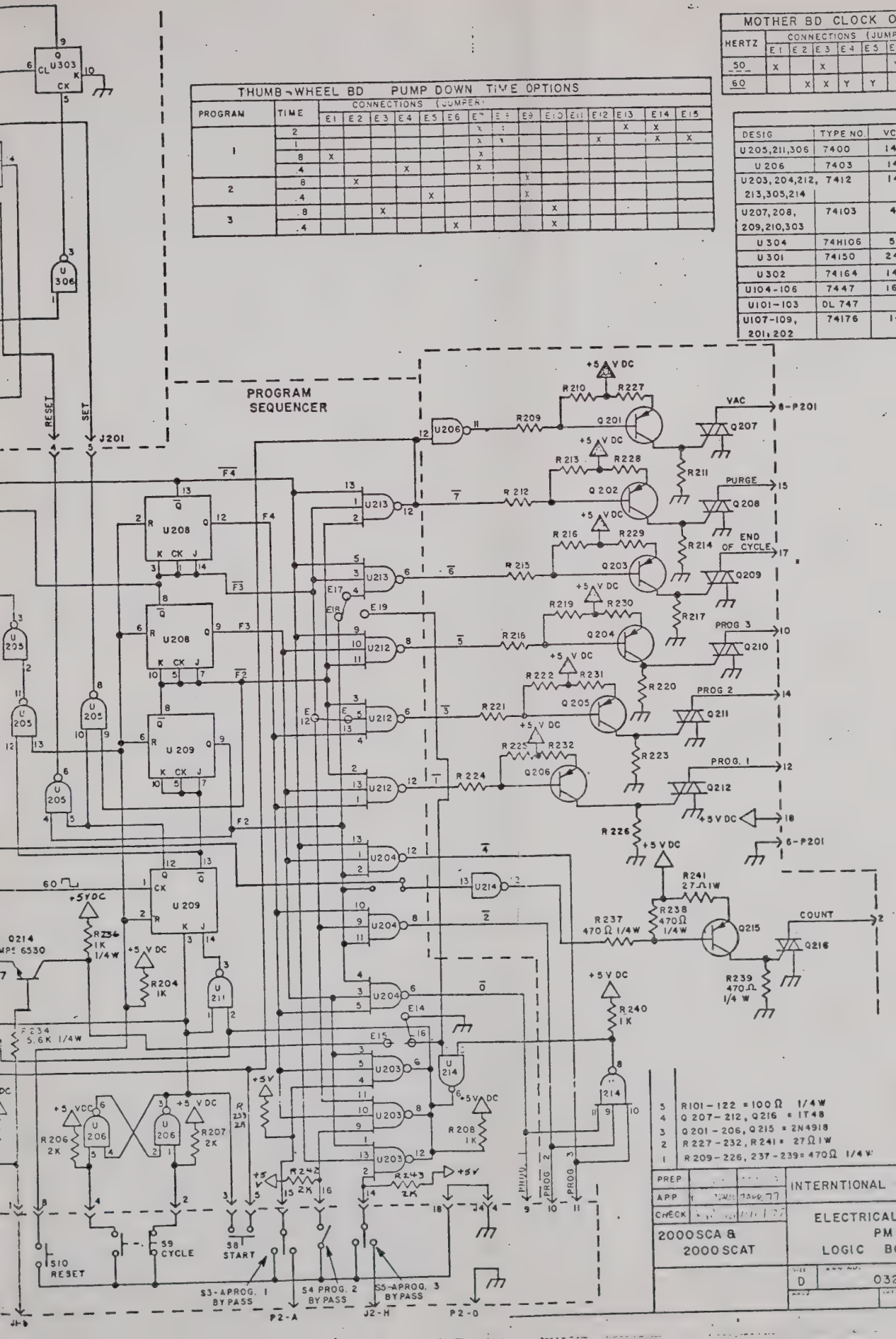
REVISION LEVEL

GRANSON/IPC
a SmithKline company

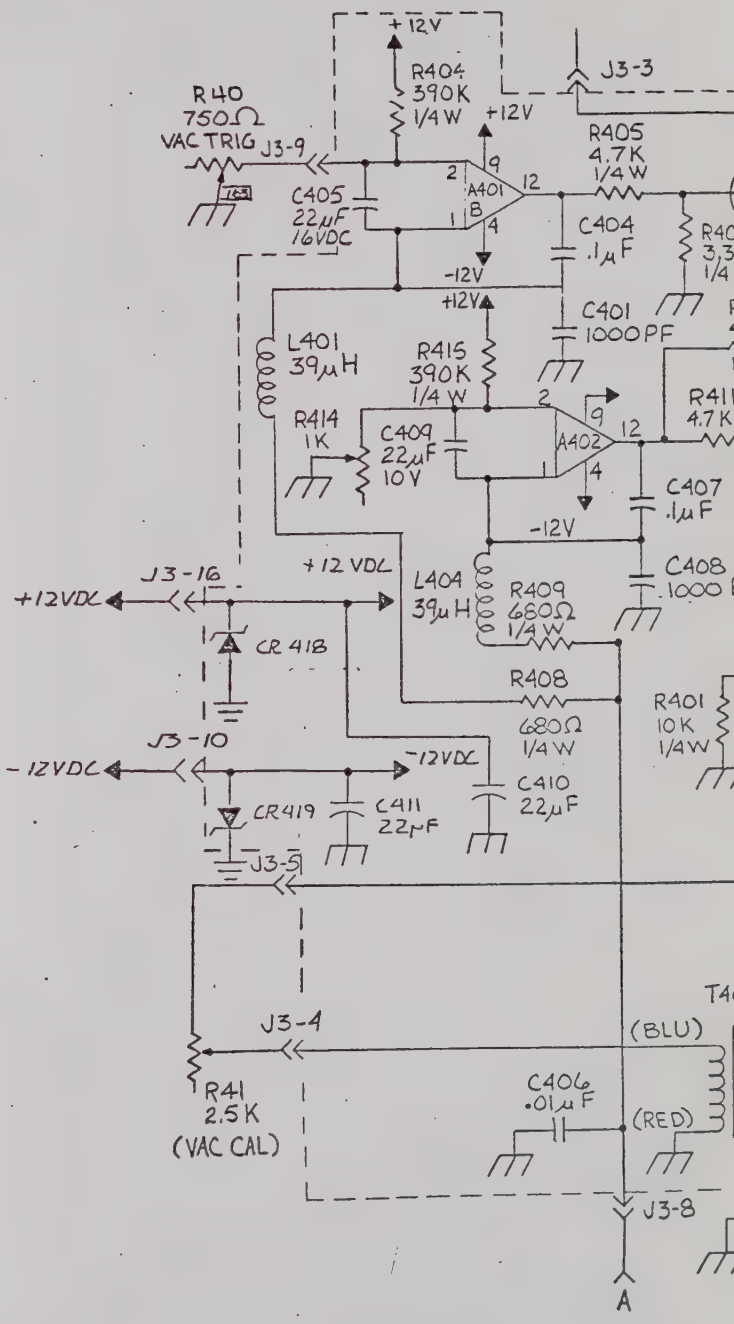
DFT K. La	DATE 10-17-85	TOLERANCES UNLESS OTHERWISE SPECIFIED .xx± .xxx± mm± ANGLES±	SURF. FIN.
CHK	DATE		
ENG	DATE 10-23	TITLE SCHEMATIC, ±12V REGULATOR	
NEXT ASSY 07772		SCALE ~ SIZE C DRAWING NO. 07785	SHT 1 OF 1 REV B
MODEL	FINISH		



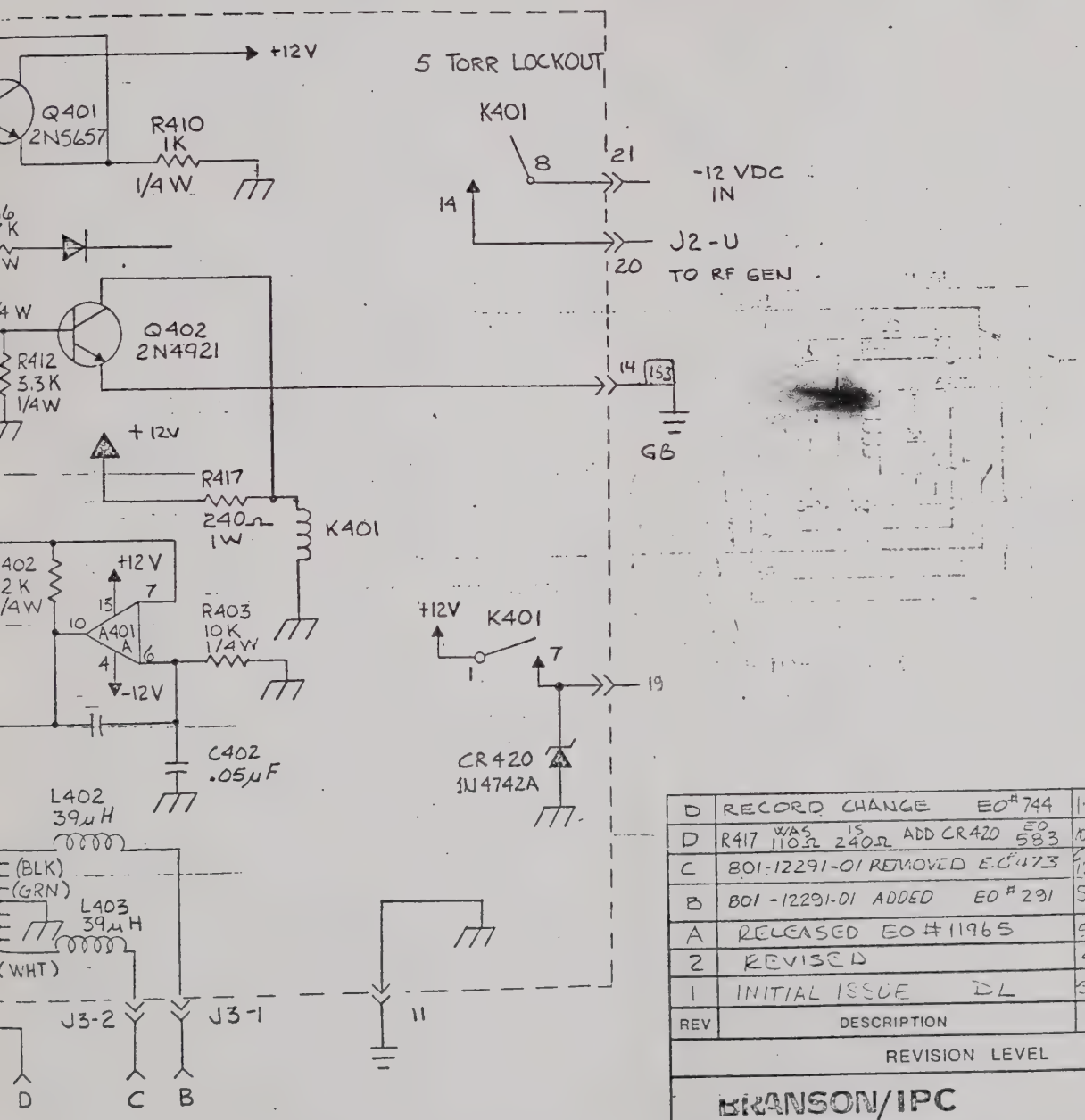
	EO 10365	KG		
	EO 10354	JV	8-25-78	
	EO 10275	JV	4-11-78	
	PEDRAW	JV	3-18-77	
V	DESCRIPTION	PREP	DATE	APPR


MOTHER BD CLOCK OPTION
HERTZ | CONNECTIONS (JUMPER) E1 E2 E3 E4 E5 E6 E7
50 | X X Y Y
60 | X X Y Y
THUMB-WHEEL BD PUMP DOWN TIME OPTIONS
PROGRAM | TIME | CONNECTIONS (JUMPER) E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15
1 | 2 | X X X X
1 | X X
8 | X X
4 | X X
2 | 8 | X X
4 | X X
3 | 8 | X X
4 | X X
DESIG | TYPE NO. | VCC | GND
U205,211,306 | 7400 | 14 | 7
U206 | 7403 | 14 | 7
U203,204,212, 213,305,214 | 7412 | 14 | 7
U207,208, 209,210,303 | 74103 | 4 | 11
U304 | 74H106 | 5 | 13
U301 | 74150 | 24 | 12
U302 | 74164 | 14 | 7
U104-106 | 7447 | 16 | 8
U101-103 | DL 747
U107-109, 201,202 | 74176 | 14 | 7
PROGRAM SEQUENCER
J201
RESET
SET
U208
U209
U213
U212
U204
U203
U214
U205
U206
U211
+5 V DC
R210
R227
R209
Q201
VAC
Q207
R211
R213
R228
R212
Q202
PURGE
Q208
R216
R229
R214
Q203
END OF CYCLE
Q209
R219
R230
R215
Q204
PROG 3
Q210
R222
R231
R220
Q205
PROG 2
Q211
R225
R232
R221
Q206
R223
PROG. 1
Q212
R224
R226
6-P201
R241 27Ω 1W
R238 470Ω 1/4W
R237 470Ω 1/4W
Q215
COUNT
Q216
R239 470Ω 1/4 W
R240 1K
R234 5.6K 1/4W
R236 1K 1/4W
R204 1K
R206 2K
R207 2K
R208 1K
R242 2K
R243 2K
S10 RESET
S9 CYCLE
S8 START
S3-APROG. 1 BY PASS
S4 PROG. 2 BY PASS
S5-APROG. 3 BY PASS
P2-A
J2-H
P2-0
J4
PROG 1
PROG 2
PROG 3
5 R101-122 = 100Ω 1/4W
4 Q 207-212, Q216 = IT48
3 Q 201-206, Q215 = 2N4918
2 R 227-232, R241 = 27Ω 1W
1 R 209-226, 237-239 = 470Ω 1/4W
PREP
APP
CHECK
INTERNTIONAL PLASMA CORP.
2000SCA & 2000SCAT
ELECTRICAL SCHEMATIC PM 906U LOGIC BOARDS
D
03208
G

NOTE: (UNLESS OTHERWISE SPECIFIED)



MATERIAL LIST			
REF.NO.	DESCRIPTION	PART NO.	QTY.



REV	DESCRIPTION	DATE	CHK	APPR
D	RECORD CHANGE EO#744	1-17-85		
D	R417 WAS 110Ω IS 240Ω ADD CR420 EO 583	10-3-84		
C	801-12291-01 REMOVED E.O.#473	5-21-84		
B	801-12291-01 ADDED EO#291	5-21-84		
A	RELEASED EO#11965	5/83		
2	REVISED	4/83		
1	INITIAL ISSUE DL	5/82		

REVISION LEVEL

BRANSON/IPC
a SmithKline company

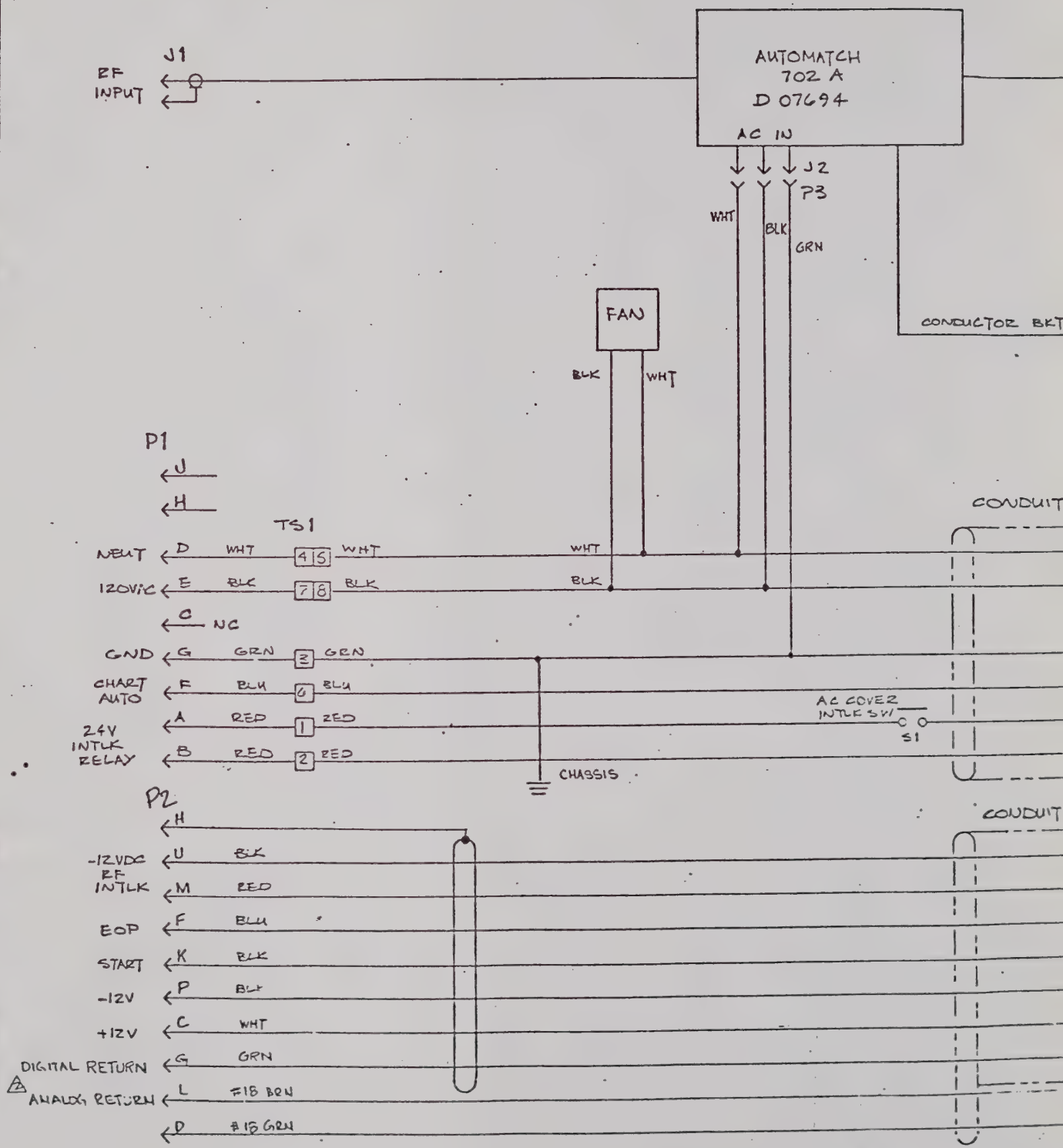
	407773	NEXT ASSY	DFT D.LUCAS	DATE 5/26/82
			CHK	DATE
			ENG	DATE 5/26/82
		MODEL	FINISH	

TOLERANCES UNLESS OTHERWISE SPECIFIED
.xx ± mm ± SURF. FIN. √
.xxx ± ANGLES ±

TITLE
VACUUM METER & CONTROL CIRCUIT OPTION

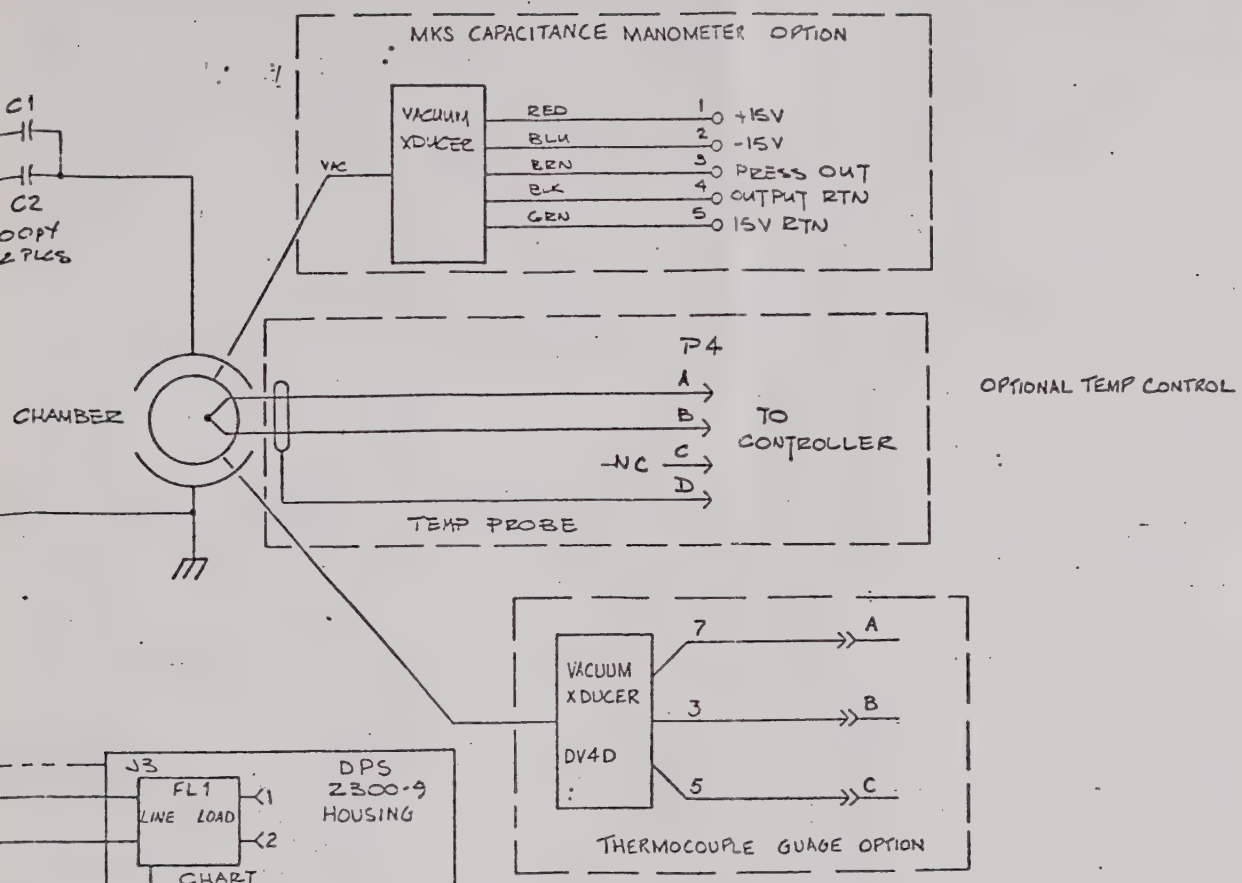
SCALE	SIZE	DRAWING NO.	SHT 1 OF	REV
	C	10454	1/1	D

NOTE: (UNLESS OTHERWISE SPECIFIED)



MATERIAL LIST

REF.NO.	DESCRIPTION	PART NO.	QTY.



REV	DESCRIPTION	DATE	CHK	APPR
A	RELEASED ECO# 11765	5/13		
2	ADD ANALOG RET	2/85		
1	INITIAL ISSUE EA			

REVISION LEVEL

BRANSON/IPC
a SmithKline company

NEXT ASSY	A10370		
	A10372		
MODEL			

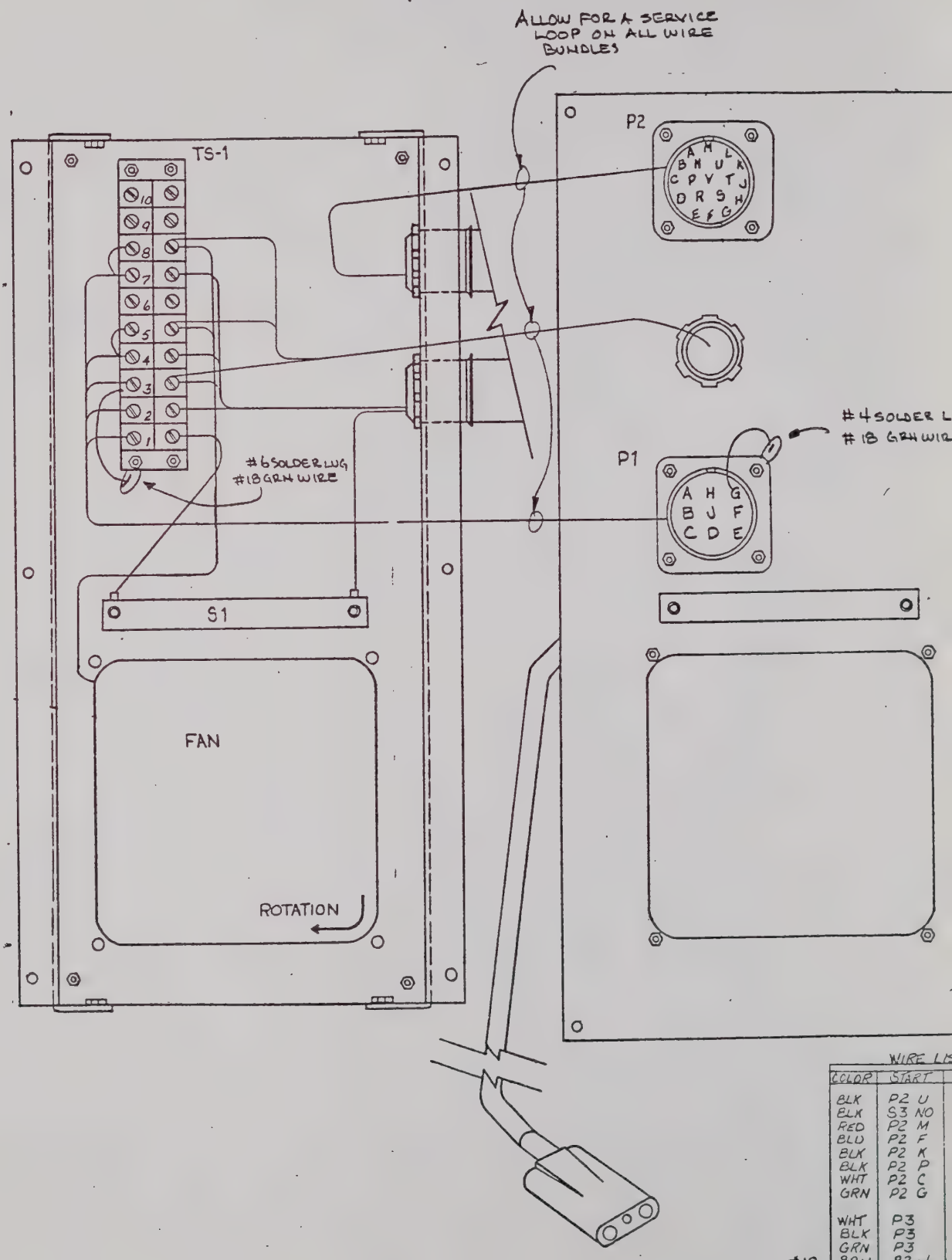
DFT S. LUCAS DATE
CHK DATE
ENG DATE 6/30/85
FINISH

TOLERANCES UNLESS OTHERWISE SPECIFIED
.XX ± .XXX ± mm ± ANGLES ± BURR. FIN.

TITLE
SCHEMATIC. COMPACT REACTOR CENTER S 2000

SCALE — SIZE D — DRAWING NO. 10455 — SHT 1/1 — REV A

NOTE: (UNLESS OTHERWISE SPECIFIED)

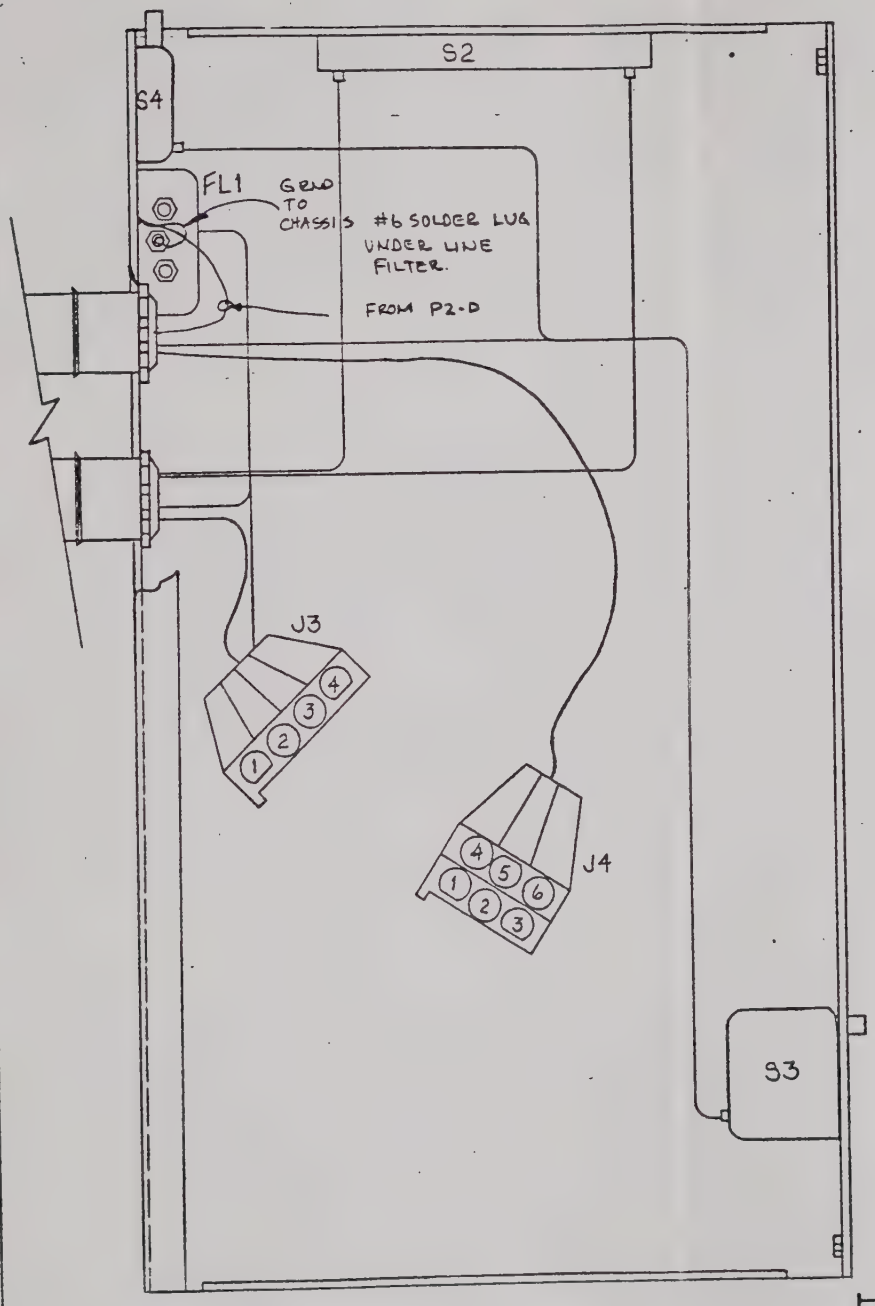


WIRE LI

COLOR	START
BLK	P2 U
BLK	S3 NO
RED	P2 M
BLU	P2 F
BLK	P2 K
BLK	P2 P
WHT	P2 C
GRN	P2 G
WHT	P3
BLK	P3
GRN	P3
#18 BRN	P2-L
#18 GRN	P2-D

MATERIAL LIST

REF.NO.	DESCRIPTION	PART NO.	QTY.



WIRE LIST

COLOR	START	END	NOTES
WHT	P1 D	TS1-4,5	
WHT	TS1-5	FAN	
WHT	TS1-4	FL1	LINE
WHT	FL1	J3-1	LOAD
BLK	P1-E	TS1-7,8	
BLK	TS1-8	FAN	
BLK	TS1-7	FL1	LINE
BLK	FL1	J3-2	LOAD
GRN	P1-G	TS1-3	
GRN	TS1-3	FL1	LINE
GRN	FL1	J3-4	
BLU	P1-F	TS1-6	
BLU	TS1-6	J3-3	
RED	P1-A	TS1-1	
RED	TS1-1	S1	
RED	S1	S2	
RED	P1-B	TS1-2	
RED	TS1-2	S2	

REV	DESCRIPTION	DATE	CHK	APPR
A	RELEASED ECS # 11965	5/13	CL	ES
2	REVISED PRELIM.	2/33		
1	INITIAL ISSUE CL	5-21-82		

REVISION LEVEL

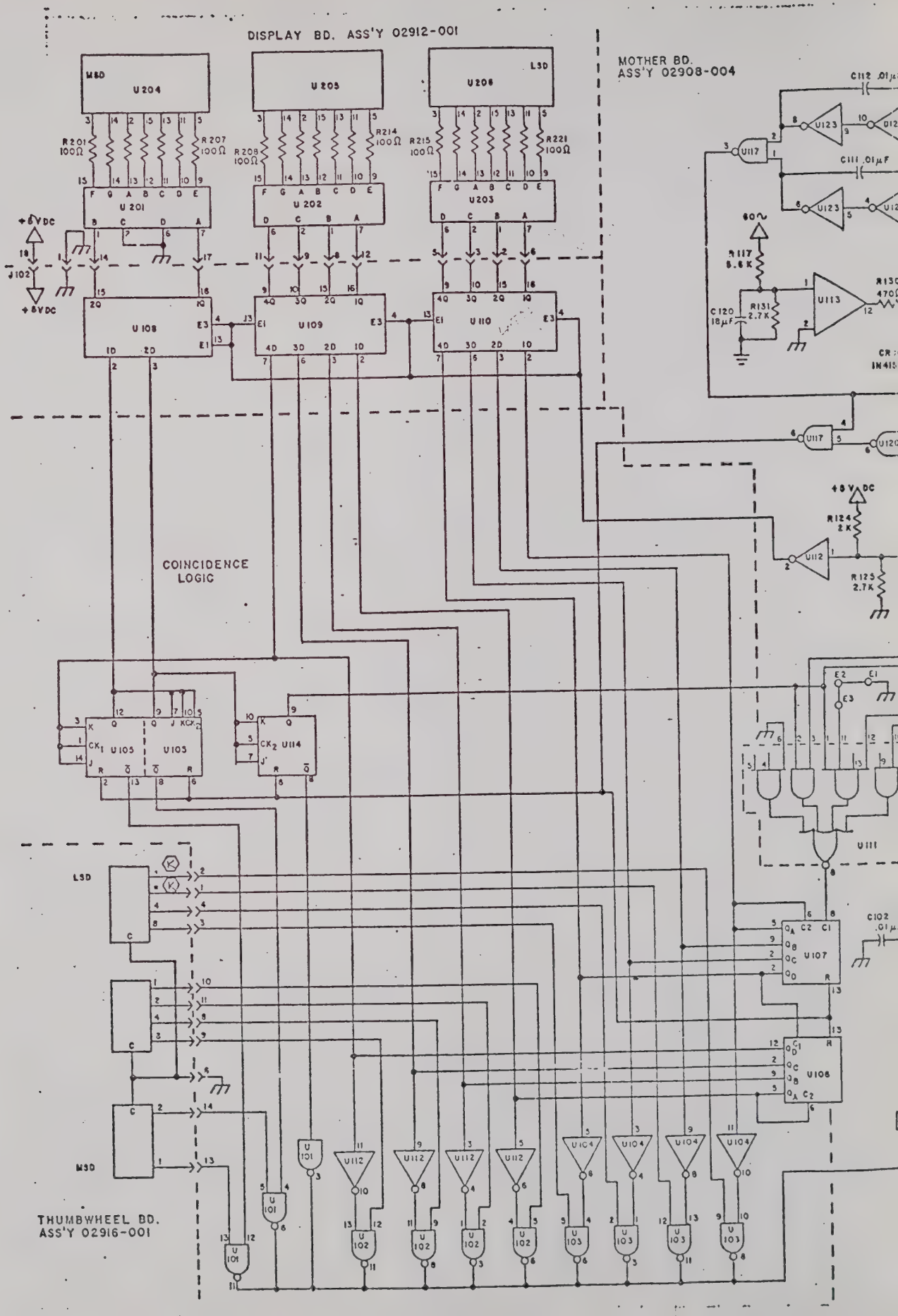
BRANSON/IPC
a SmithKline company

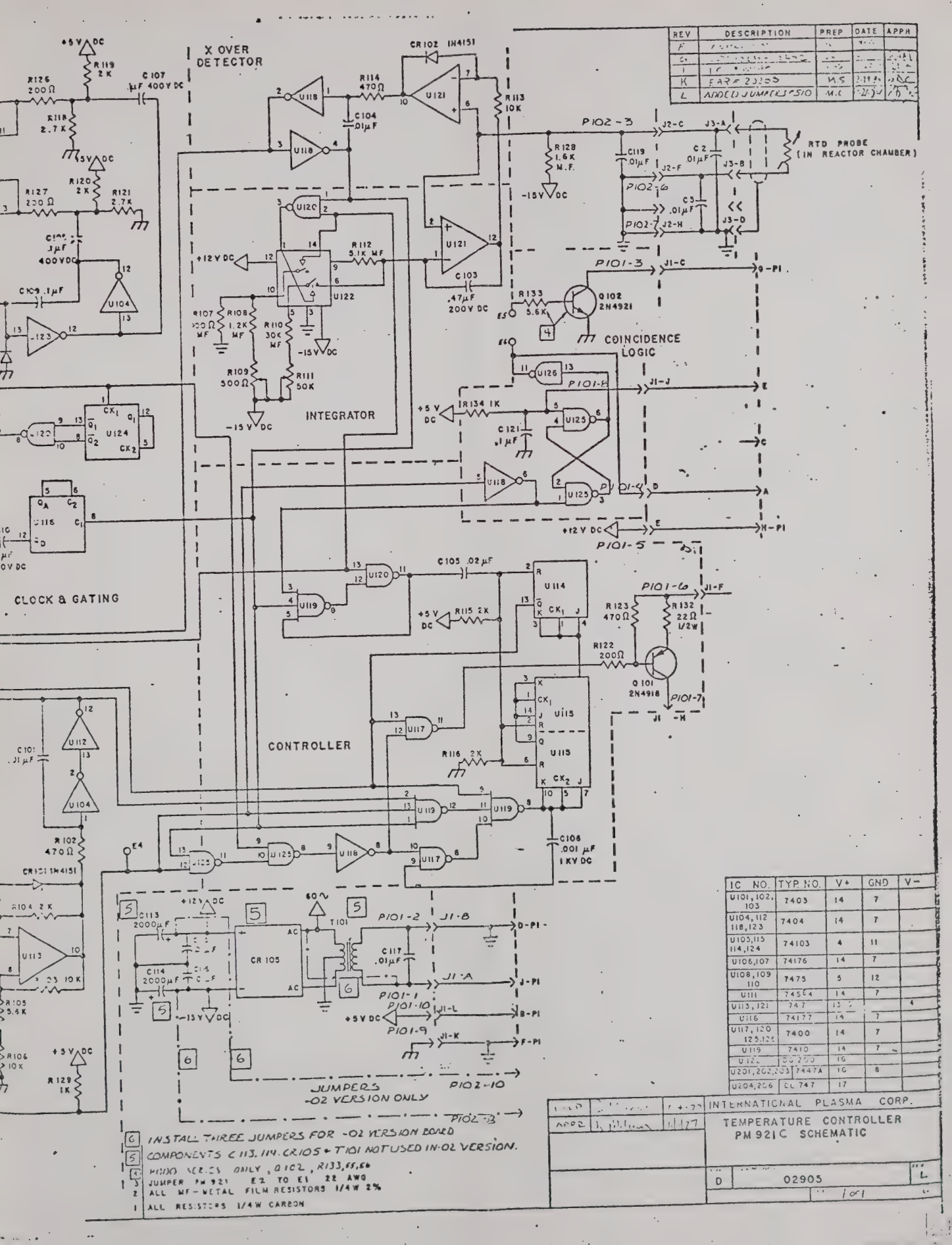
DFT	D LUCAS	DATE 6/21/82
CHK		DATE
ENG		DATE 5/27/83
NEXT ASSY		
MODEL		
FINISH		

TOLERANCES UNLESS OTHERWISE SPECIFIED
.XX ± mm ± SURF. FIN. √
.XXX ± ANGLES ±

TITLE WIRING DRAWING COMPACT REACTOR CENTER

SCALE	SIZE	DRAWING NO.	SHT / OF	REV
FULL	D	010470	1/1	A


DISPLAY BD. ASS'Y 02912-001
MOTHER BD.
ASS'Y 02908-004
MSD
LSD
U 204
U 205
U 206
R201 100Ω
R207 100Ω
R208 100Ω
R214 100Ω
R215 100Ω
R221 100Ω
U 201
U 202
U 203
+5VDC
J102
U 108
U 109
U 110
COINCIDENCE LOGIC
U 105
U 103
U 104
U 111
U 107
U 106
U 101
U 112
U 102
U 113
U 123
U 117
C112 .01μF
C111 .01μF
60~
R117 5.6K
C120 18μF
R131 2.7K
48VAC
R124 2.2K
R125 2.7K
C102 .01μF
THUMBWHEEL BD.
ASS'Y 02916-001



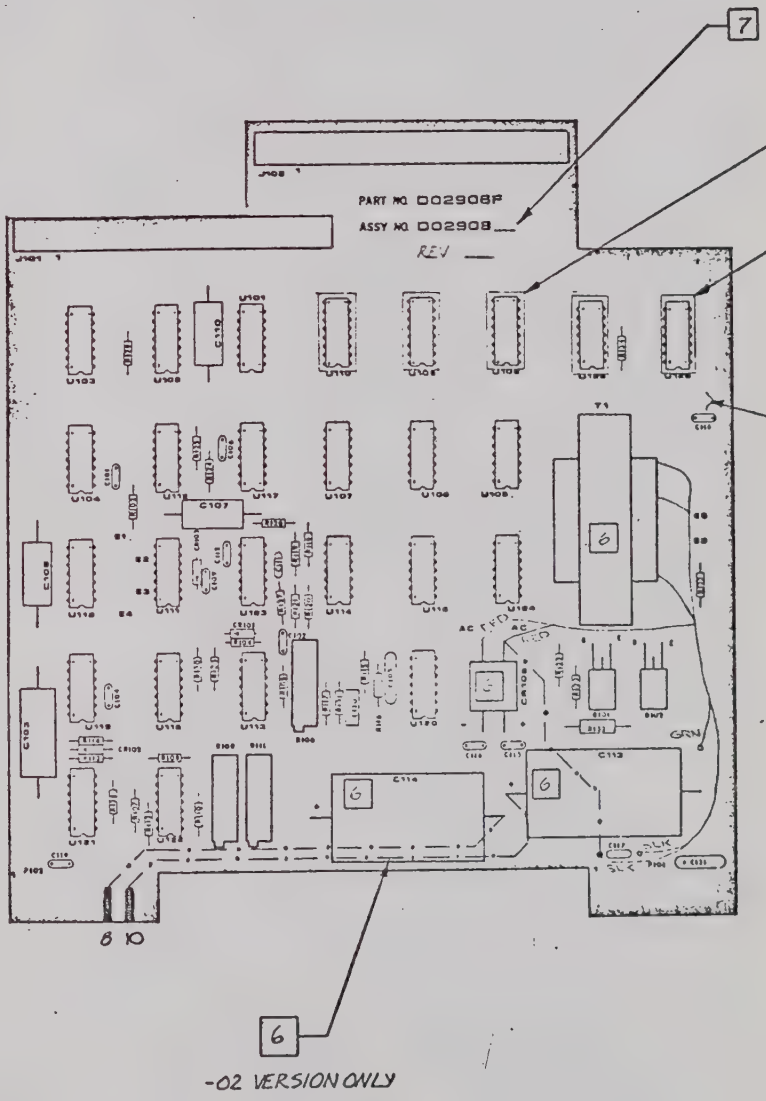
REV	DESCRIPTION	PREP	DATE	APPR
F	[illegible]	[illegible]	[illegible]	[illegible]
J	[illegible]	[illegible]	[illegible]	[illegible]
K	PARTS ADDED	M.S.	2-11-80	D.C.
L	ADDED JUMPERS P310	M.C.	2-13-80	D.C.

IC NO.	TYP. NO.	V+	GND	V-
U101, 102, 103	7403	14	7	
U104, 112 118, 123	7404	14	7	
U105, 115 114, 124	74103	4	11	
U106, 107	74176	14	7	
U108, 109 110	7475	5	12	
U111	74S64	14	7	
U113, 121	747	13	[illegible]	4
U116	74177	14	7	
U117, 120 125, 126	7400	14	7	
U119	7410	14	7	
U122	80 200	16		
U201, 202, 203	7447A	16	8	
U204, 206	DL 747	17		

DRWN	[illegible]	[illegible]	INTERNATIONAL PLASMA CORP.
APPD	[illegible]	1/27	TEMPERATURE CONTROLLER PM 921C SCHEMATIC
			D 02905 L
			SHT 1 OF 1

NOTE: (UNLESS OTHERWISE SPECIFIED)

1. MOUNT ALL COMPONENT 1/8 INCH OFF BOARD, EXCEPT IC SOCKETS, TRIMPOTS, XMFR. AND EDGE CONN
2. PM921 JUMPERS E1 TO E2 #22 GA WIRE.
3. PM923 JUMPERS E3 TO E4 #22 GA WIRE.
4. PM921 8000 SERIES: Q102, R133, E1 TO E2, E5 TO E6.
5. PM923 8000 SERIES: Q102, R133, E2 TO E4, E5 TO E6.
6. FOR 02908-02 VERSION DO NOT INSTALL C113, C114, CR105, & T1
   INSTALL JUMPER FROM E1 TO E2.
   INSTALL JUMPER FROM NEGATIVE (-) END C116 TO P102-8 (VIO #22 AWG).
   INSTALL JUMPER FROM POSITIVE (+) END C115 TO P102-10 (VIO #22 AWG).
   INSTALL JUMPER FROM AC OF CR105 TO P101 SIDE OF C117 (RED #22 AWG).
7. PERMANENTLY MARK ASSY WITH PROPER NUMBER, DASH Nº IF REQUIRED, AND REVISION LETTER.



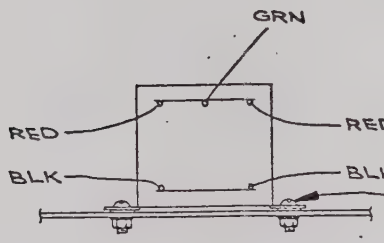
TORS.

MATERIAL LIST			
REF.NO.	DESCRIPTION	PART NO.	QTY.

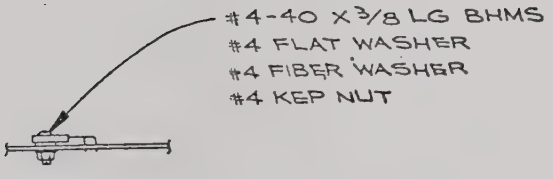
(3)
(3)

(2)
(23)

(1)



MTG DETAIL OF T1



MTG DETAIL OF Q101, Q102

02903-02	6
02903	2 . 5
PART NO.	DESCRIPTION

REV	DESCRIPTION	DATE	CHK	APPR
L	ADD NOTES 6, 7 PER EO # 510	12-1-92	[illegible]	[illegible]
K	EO# 12090	[illegible]	[illegible]	[illegible]
J	EO #11404 [illegible]	[illegible]	[illegible]	[illegible]

REVISION LEVEL

BRANSON/IPC
a SmithKline company

04483	NEXT ASSY	DFT D YH	DATE 11-6-92
02492		CHK [illegible]	DATE 11-12-92
02105		ENG [illegible]	DATE [illegible]
	MODEL	FINISH	

TOLERANCES UNLESS OTHERWISE SPECIFIED
.XX ± mm ± BURR, FIN ✓
.XXX ± ANGLES ±

TITLE
MOTHER BOARD ASSY
TEMP CONTROLLER
PM 921

SCALE	SIZE	DRAWING NO.	SHT / OF	REV
1:1	D	02903-XX	1/3	L

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION

INSTRUCTION MANUAL

for

PM 702A

AUTOMATCH

A 00110 Rev D
9 August 1977

31172 Huntwood Avenue
P.O. Box 4136, Hayward, CA 94544
(415) 489-3030 Telex: 337-759

INSTRUCTION MANUAL
for
IPC PM 701-702-703
AUTOMATCH

1.0 INTRODUCTION

1.1 Description

The R.F. Generator is designed and calibrated to drive a fixed 50 ohm resistive load. However, the reactor and plasma present a resistive/capacitive load. Its amplitude and phase depend upon the type and size of chamber and upon various operating parameters, e.g. power level, pressure, type of gas, and temperature. Therefore, a network which matches the impedance of the reactor to the desired 50 ohms is provided in each Reactor Center. The AutoMatch system continuously and automatically adjusts the matching network over the full operating range of the Reactor Center.

The matching network is a capacitor-inductor-capacitor pi network. Both amplitude and phase of the impedance at the input to the network must be correct, i.e. 50 ohms and zero degrees. This requires the adjustment of two components. Therefore both capacitors in the network are variable and are motor-driven. The series inductor is fixed.

As in any parallel tuned RLC network there are two values of capacitance for resonance (phase equals zero). In this application the only legitimate resonance is one where the magnitude of the input current is less than the magnitude of the current in the input capacitor, i.e. $/I_{in}/ < /I_{ci}$, (See Figure A). AutoMatch insures that this relationship holds by automatically increasing Ci and Co if $/I_{in}/ > /I_{ci}$.

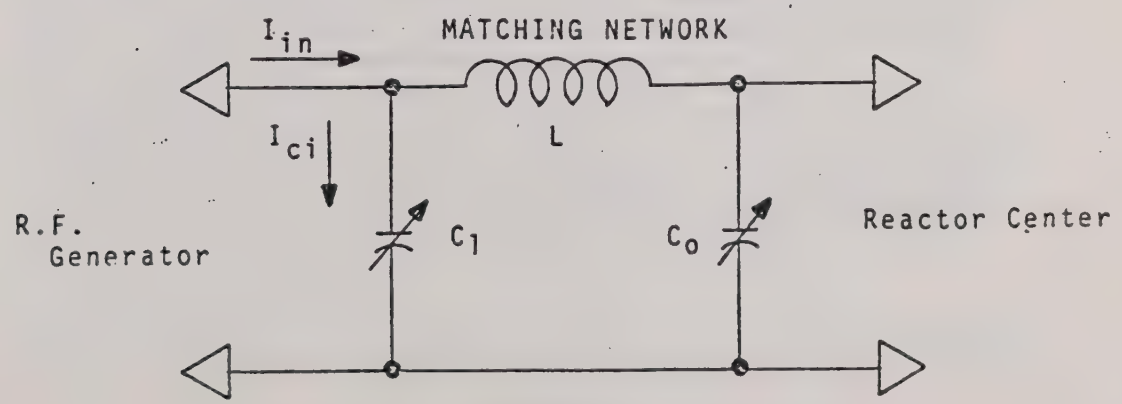


FIGURE A

2.0 OPERATION

The operation of AutoMatch is completely automatic over the functional range of the Reactor Center and requires no operator intervention.

3.0 FUNCTIONAL DESCRIPTION

3.1 Functional Inclusions

An R.F. Coupler which detects the inpedance at the input to the matching network, and provides signals indicative of errors in both amplitude and phase. The coupler also detects $/I_{in}/$ for subsequent comparison to $/I_{ci}/$.

3.2 An amplifier section which amplifies the error signals, i.e. amplitude error and phase error, and amplifies the signal comparing $/I_{ci}/$ and $/I_{in}/$.

3.3 A motor and gear drive section mechanically coupled to the rotors of the air variable capacitors of the matching network. The motors are driven by the appropriate amplifiers in the amplifier section, adjusting the capacitances for minimum error signals.

3.4 The pi matching network consisting of the variable capacitor at the input and output terminals and the series fixed inductor. It also includes circuitry to detect $/I_{ci}/$ for processing with $/I_{in}/$ in the amplifier section.

4.0 CIRCUIT DESCRIPTION

Refer to drawing C02661 for the schematic of AutoMatch.

4.1 R.F. Coupler

The R.F. Coupler, shown schematically within the dashed lines, is an arrangement of lumped components and distributed components mechanically arranged to generate D.C. voltages which, when properly combined, yield the appropriate error signals for both amplitude and phase. The phase error is proportional to the sum of voltages Vp1 and Vp2, which are the D.C. voltages developed on capacitors C205 and C204, respectively. The amplitude error is proportional to the sum voltages Va1 and Va2, which are the D.C. voltages developed on capacitors C207 and C206, respectively. Va1 is proportional to the total input current.

4.2 Phase Error Amplifier

The voltages Vp1 and Vp2 are summed algebraically by the phase error amplifier through input resistors R101 and R102. R108 is a potentiometer to adjust for any minor misalignment in the coupler. The phase error amplifier is a feedback amplifier comprised of A101 with output buffer power transistors Q101 and Q102. The amplifier drives the D.C. motor M202 which is mechanically geared to the rotor of the variable air capacitor C202*, the output capacitor of the matching pi network. The forward gain of the amplifier is determined by the voltage feedback via R116.

4.3 Limit Switches

Switch S201 and S202 are "limit" switches positioned to limit the range of rotation of the rotor of variable air capacitor C202. If the motor is driven by a positive voltage, the capacitor rotor will rotate to its extreme position when S202 is opened. Diode CR206 then prevents current through the motor until the amplifier output voltage is reversed. Limit switch S201 and CR205 similarly restrict the range of capacitor rotation for negative voltage drive.

4.4 Amplitude Error Amplifier

The amplitude error amplifier is identical to the phase error amplifier, driving D.C. motor M201 which is geared to the rotor of variable air capacitor C201*. Capacitor C201 with the fixed capacitors C211 and C212 comprise the input capacitance of the pi matching network. The current through the input capacitance (referred to previously as I_{ci} and ci respectively) is detected by virtue of the voltage across the "gimmick" inductor and rectifier diode CR209. The resulting D.C. voltage Vi is added algebraically with Va in amplifier A101 through input resistor R121, R123, and potentiometer R122. If the input current, represented by Va, exceeds I_{ci} the output of amplifier A101 becomes positive polarity. Diodes CR102 and CR101 then become forward biased driving the outputs of both error amplifiers positive. This results in C201 and C202 being driven to maximum capacitance.

4.5 Power Supply

Supply voltages B+ and B- of +15 and -15 volts respectively, are generated by two full wave rectifiers comprised of T1, capacitors C3, C4, and a diode bridge.

---

* For PM702 and PM703 the reference designator for C201 is C215 and the reference designator for C202 is C216.

5.0 MAINTENANCE

WARNING: HIGH R.F. VOLTAGES EXIST THROUGHOUT THE UNIT. R.F. POWER SHOULD BE REMOVED DURING MAINTENANCE.

5.1 Electrical

All R.F. Coupler and Potentiometer alignments are made at the factory and require no further adjustment.

5.2 Mechanical

For ease of maintenance and to protect the motor driven gear heads, each drive train includes a slip clutch. The D.C. motors, gear heads, spur gears, slip clutch, and variable capacitors are precisely positioned at the factory. If it becomes necessary to replace any of these parts, exercise care in mating the spur gear on the capacitor shaft with the nylon slip clutch gear. The gear teeth should engage approximately 80-90% without binding for a full 360 rotation.

5.2.1 Excessive backlash, symptomized usually by a system oscillation (or hunting) may be caused by loose gears or set screws and/or improperly meshed gears.

5.2.2 The slip force on the slip clutch assemblies is set at the factory. If readjustment is necessary, the spring tension should be set to require a motor current of 25 ma at 12 volts with the nylon gear in a fixed position.

5.3 Capacitor Replacement

If replacement of a variable capacitor, C201 or C202, becomes necessary the following should be observed:

5.3.1 The spur gear should be firmly set on the capacitor shaft.

5.3.2 The limit switch actuating arm should be firmly set on the capacitor shaft with the following orientation:

With the limit switch actuating arm set parallel to the AutoMatch baseplate, the capacitor rotor should be set for 50% capacitance. The limit switch actuating arm should be toward the outer edge of the baseplate, and the capacitor rotor should be toward the center of the baseplate.

5.4 Adjusting the Reflected Power

This adjustment should only be necessary in the event that the PM 701/702/703 is retrofitted in the field. Make the adjustment at one torr of oxygen and with an R.F. level of 300 watts per chamber.

5.4.1 Units Without DPS-1000

Refer to figure 6. There are three adjustable resistors in the auto tuner. These are accessible through a vertical slot in the rear panel of the Reactor Center, and the one of concern is R108, the center resistor. Observing the reflected power on the system power meter, adjust R108 for minimum reflected power. If the system "hunts" or oscillates, turn R108 clockwise until "hunting" ceases. The reflected power should be less than 6 watts.

5.4.2 Units with DPS-1000

Refer to figure 7. There are five adjustable resistors in the Auto tuner/DPS-1000. These are accessible through a vertical slot in the rear panel of the Reactor Center and the one of concern is R108, the second resistor from the top. Observing the reflected power on the system power meter, adjust R108 for minimum reflected power. If the system "hunts" or oscillates, turn R108 clockwise until "hunting" ceases. The reflected power should be less than 6 watts.

5.5 Tuning Procedure

5.5.1 Remove L201 and disconnect strap from coupler to C201.

5.5.2 Loosen motor clamp.

5.5.3 Disengage motor gears from C201 and C202 gears by pulling motor housings back into tuner body.

5.5.4 Gently tighten motor bracket to hold motors in place.

5.5.5 Open C201 to minimum capacitance position; keep it off both limit switches. There should be two 100pf ceramic tubular capacitors in the padder bracket of C201.

5.5.6 Open C202 to middle position.

5.5 (continued)

5.5.7 Refer to figure 2 for potentionmeter locations (R108, R111, & R122).

5.5.8 Remove A102.

5.5.9 Connect a 50 ohm dummy load directly to coupler output - nothing else should be connected to coupler output at this time.

5.5.10 Plug 701-702-703 into 117 volts AC supply.

5.5.11 Connect a 500 watt generator to coupler input.

NOTE: DURING THE FOLLOWING STEPS; COVER THE COUPLER SIDE ONLY WITH ALUMINUM SAFETY COVER TO PREVENT ACCIDENTAL CONTACT WITH HIGH VOLTAGES PRESENT IN THE R.F. COUPLER SECTION.

5.5.12 Turn generator on and up to 500 watts.

5.5.13 Adjust R108 until M202 turns clockwise (viewed from Gearhead end of the motor). Manually close switch S202, and observe that the motor does not stop rotating. Manually close switch S201 and observe that the motor stops.

5.5.14 Adjust R108 until M202 turns counter clockwise (viewed from gearhead end of the motor). Manually close S201 and observe that M202 does not stop. Manually close S202 and observe that the motor stops.

5.5.15 Adjust R108 until M202 stops. This will balance A101A for zero output.

5.5.16 Adjust R111 until M201 turns clockwise (viewed from the gearhead end of motor). Manually close S203, and observe that M201 does not stop rotating. Manually close S204 and observe that M201 stops.

5.5.17 Adjust R111 until M201 turns counter clockwise. Manually close S204 and observe that M201 does not stop rotating. Manually close S203 and observe that M201 stops.

5.5.18 Adjust R111 until M201 stops. This will balance A101B for zero output.

5.5.19 Disconnect AC power from PM 701/702/703. This will bleed supplies via M201 and M202.

5.5 (continued)

5.5.20 Turn off R.F. Power.

5.5.21 Disconnect 50 ohm dummy load.

5.5.22 Connect strap from 701 and 702 coupler output in C201. C201 should be the only thing connected at this point.

5.5.23 Install A-102 and reconnect to 117 volt AC supply.

5.5.24 Turn up R.F. to 50 watts.

5.5.25 Adjust R122 until neither M201 nor M202 rotate toward minumum capacitance.

5.5.26 Turn of R.F. Power.

5.5.27 Install L201.

5.5.28 Connect simulated load.
EXAMPLE: (refer to next page) Figure B.

5.5.31 (continued)

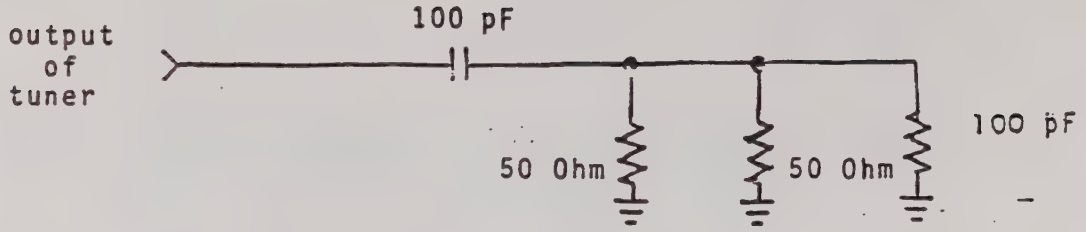


FIGURE B

5.5.31.1 Engage motors M201 and M202 to their proper positions.

5.5.32 Replace top cover.

5.5.33 Turn on R.F. Power to 500 watts if obtainable.

5.5.34 Rotate R108 clockwise for 6 watts or less reflected and 500 watts forward.

5.5.35 Turn off R.F. Power and disconnect generator.

5.5.36 Remove 117 volt AC supply from 701-702-703.

5.5.37 Disconnect simulated load.

5.5.38 Recheck mechanical connections.

5.6 Adjusting the Operating Range

The matching is achieved by virtue of two motor driven capacitors. Each of these capacitors has a limited range over which it will vary. They have been selected to accommodate the various operating parameters of a system, e.g. gas flow, pressure, R.F. Power, but differences in Reactor Chambers may require adjustment of the location or center of the range.

5.6.1 Upon installation of the unit in the system, note there is an upper variable capacitor with fixed capacitors in parallel with it, and mounted on a bracket on the variable capacitor. The location or center of the range for this variable capacitor is determined by the number of fixed capacitors on the bracket. If the range is such that the variable capacitor approaches or reaches its maximum value (fully meshed), it may be brought closer to the center or away from the maximum by adding fixed capacitance. Conversely, if the variable capacitor

5.6.1 (continued)

approaches or reaches its minimum value, it may be brought closer to the center or away from the minimum by removing fixed capacitance.

5.6.2 The upper variable capacitor is connected to the lower variable capacitor through a fixed inductor of approximately 6 turns of wound tubing. Although the inductor is fixed, its value can be adjusted by compressing the length so that the turns are closer together, or by stretching the length so that the turns become further apart. Compressing increases the inductance and stretching decreases the inductance. Adjusting the value of this inductor is the mechanism for centering the range of the lower variable capacitor. However, in order to adjust the inductor, first unfasten the top of the inductor. Refasten it after adjusting.

5.6.3 If the lower variable capacitor approaches or reaches its maximum value, it may be brought closer to its center or away from its maximum by increasing the inductance (compressing the inductor). If the lower variable capacitor approaches or reaches its minimum value, it may be brought closer to its center or away from its minimum by decreasing the inductance (stretchint the inductor). If the stretching or compressing of the inductor becomes too extreme, it may be necessary to use an inductor with a different number of turns. Increasing the number of turns increases the inductance. There are two inductors supplied with the unit in case substitution for the one installed is necessary.

5.6.4 The table below shows the operating parameters which the units are adjusted to cover at the factory. In case of retrofitting in the field, it may be necessary to readjust for the particular chamber(s) in the reactor. Simply set up each of the conditions, and for each verify that the variable capacitors are in their operating range, i.e. not at a minimum or maximum value. Correct or adjust the ranges by procedure described above.

8" x 18" CHAMBER	
ETCHING WITH TUNNEL	0.3 to 1.7 TORR 50 to 400 WATTS/CHAMBER
STRIPPING WITH OR WITHOUT TUNNEL	7.0 to 3.0 TORR 300 to 500 WATTS/CHAMBER
10" x 18" CHAMBER	
ETCHING WITH TUNNEL	0.3 to 1.7 TORR 150 to 450 WATTS/CHAMBER
STRIPPING WITH OR WITHOUT TUNNEL	1.0 TO 3.0 TORR 400 to 700 WATTS/CHAMBER

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
122	POTENTIOMETER 20K	4750-0010	1
	BOURNES 3069P-1-203		
R108, 111	POT 10K	4750-0013	2
	BOURNES 3069P-1-103		
A101	OPERATIONAL AMP	4800-0012	2
102	FAIRCHILD 747		
CR101, 102	DIODE	4800-0045	2
	IN4151		
Q101	TRANSISTOR	4800-0047	2
103	MOTOROLA 2N4921		
E Q102	TRANSISTOR	4800-0046	2
104	MOTOROLA 2N4918		
3	SCREW		4
	4-40 UNC-2A X .375 BHMS STL		
4	NUT		4
	4-40 KEPNUT STL		
5	WASHER		4
	4. FLAT FIBER WASHER		

DIONEX
GAS PLASMA DIVISION
31159 SAN BENITO
HAYWARD, CALIF.
94544

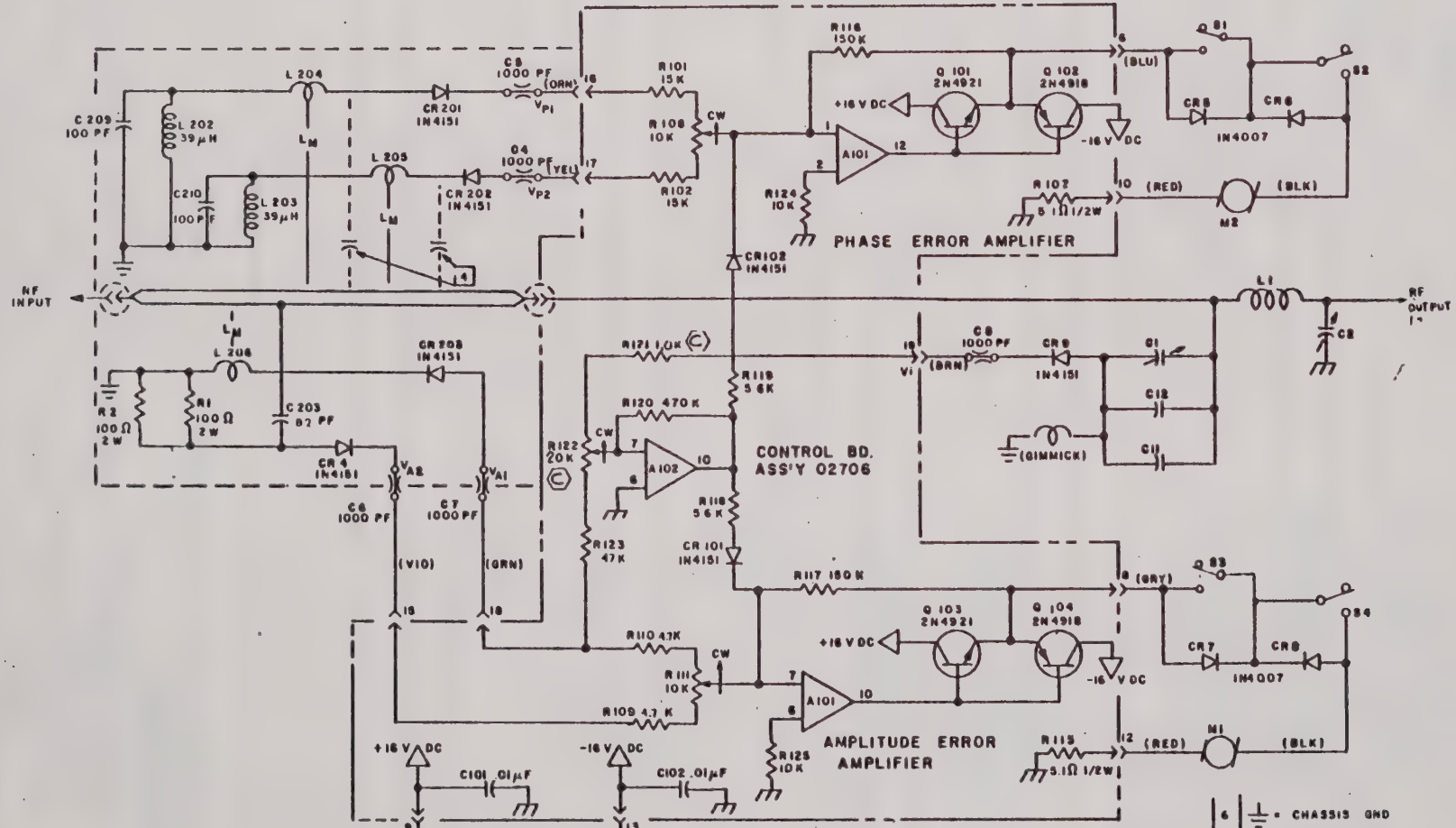
TITLE
PM 702, 703
AUTOMATCH CIRCUIT BOARD ASSEMBLY

SIZE	DWG. NO.	REV	CHK.	APPR.
B	03690	F		

DRAWN	DATE	SHEET 3 OF 3
K.G.	5/7/79	

A 04289 REV

REV	DESCRIPTION	APP	DATE	APPR
B	EO-10348	KG	4-15-74	KF
C	EAR-20322	PB	5-28-90	



IC CHART				
DESIG	TYPE NO	Vcc +	GND	Vcc −
A101-102	747	9,13		4

6 ⏚ = CHASSIS GND

5 ⏚ = COMMON GND ON CIRCUIT BD

4 HIDDEN LINE SYMBOLS INDICATE CAPACITANCE BETWEEN TWO CONDUCTORS

3 L_M - INDICATES MUTUAL COUPLING

2 FACTORY SELECTED FOR APPLICATION

1 ALL RESISTORS CARBON COMPOSITION 1/4 W UNLESS OTHERWISE SPECIFIED

INTERNATIONAL PLASMA CORP

ELECTRICAL SCHEMATIC AUTOMATIC IMPEDENCE MATCHING NETWORK PM 702

C

REV	B
DWG NO.	07694

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION		DATE	CHK	APPR
B	E.O. #12174 9-29-83	RFE	9.29.83		
A	RELEASED E.O. #11965	BJ	5-13-83	CC	BJ
3	REVISED	BJ	3-8-83		
2	REVISED	BJ	4-19-82		
1	PRELIMINARY		7-10-81		

REVISION LEVEL

NEXT ASSY.
A 07693
A 10370
A 10371
A 10372

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
AUTOMATCH ASSEMBLY
PM 702-A

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07694	B		

DRAWN	DATE
E.AcM	6-30-81

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
13	BASE PLATE MOUNTING BRACKET	B 02814	1
7	HOUSING RF PARTITION	C 02817	1
6	HOUSING COVER	C 02818	1
5	MOTOR CRADLE	B 02819	1
4	RF CONDUCTOR SUPPORT PLATE	B 02820	1
2	RF CONDUCTOR STRAP, LOWER	B 02825	1
32	RF COUPLER ASSEMBLY	C 02827	1
1	LIMIT SWITCH STOP BRACKET	B 03064	2
12	INPUT CAPACITOR BRACKET	B 03212	1
C1	INPUT CAPACITOR ASSEMBLY	C 03470	1
M1	INPUT MOTOR ASSEMBLY	B 03471	1
	CIRCUIT BOARD ASSEMBLY	B 03690	1
15	INPUT CAPACITOR BRACKET	B 04396	1
M2	OUTPUT MOTOR ASSEMBLY	B 04416	1
14	RF CONDUCTOR COUPLER	B 04427	1
16	MOTOR CAP	B 04432	1
C2	OUTPUT CAPACITOR ASSEMBLY	D 10486	1
11	BASE PLATE	D 04482	1
8	HOUSING REAR ANGLE	C 07695	1
9	HOUSING FRONT ANGLE	D 07696	1
L1	INDUCTOR, 6-1/2 TURNS	B 02824	A/R
L1	INDUCTOR, 7-1/2 TURNS	B 04455	A/R
L1	INDUCTOR, 8-1/2 TURNS	B 04456	A/R
L1	INDUCTOR, 9-1/2 TURNS	B 04457	A/R
L1	INDUCTOR, 10-1/2 TURNS	B 04458	A/R
L1	INDUCTOR, 11-1/2 TURNS	B 04459	A/R
L1	INDUCTOR, 2-1/2 TURNS	B 04460	A/R
L1	INDUCTOR, 3-1/2 TURNS	B 04461	A/R
L1	INDUCTOR, 4-1/2 TURNS	B 04462	A/R
L1	INDUCTOR, 5-1/2 TURNS	B 04463	A/R
	SCHEMATIC	C 04499	REF

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE

AUTOMATCH ASSEMBLY
PM 702-A

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07694	B		

DRAWN	DATE	SHEET	OF
B.J.	4-19-82	2	4

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
	CONTROL BOARD BOX	C 09748	1
C11, 12	TRANSMITTING CAP 100 pF 5 KV	1500-0189	2
C4-8	CAPACITOR, FEEDTHRU 1000 pF	1500-0205	5
C3, 9	CAPACITOR, 2000 uF 24V	1500-0208	2
P2	EDGE CONNECTOR, 22 PIN	2100-0223	1
E1-6	INSULATED TERMINAL, USECO #1417-9	2160-0207	6
J1	RF CONNECTOR	2180-0190	1
FL1	FILTER, LINE 10 AMP	2700-0003	1
17	2" CERAMIC STANDOFF	3100-0142	1
R1-2	RESISTOR, C.C. 100 OHM 2W	4705-0101	2
CR5-8	DIODE, MOTOROLA IN4007	4800-0013	4
CR3	DIODE BRIDGE, INT. RECTIFIER #18DB2A	4800-0044	1
CR4, 9	DIODE, MOTOROLA IN4151	4800-0045	2
S1-4	SWITCH SPDT, MOMENTARY-ON	5100-0154	4
T1	TRANSFORMER	5600-0006	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
AUTOMATCH ASSEMBLY
PM 702-A

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07694	B		

DRAWN	DATE	SHEET
B.J.	4-19-82	SHEET 3 OF 4

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
21	SCREW, 10-32 UNF 2A x 1.50 BHMS STL		1
22	SCREW, 8-32 UNC 2A x 1.25 SHCS STL		2
23	SCREW, 6-32 UNC 2A x .187 BHMS BRASS		11
24	SCREW, 10-32 UNF 2A x .375 BHMS BRASS		1
25	NUT, 6-32 UNC 2B, BRASS HEX		3
27	LOCKING TERMINAL LUG		1
28	SCREW, 8-32 UNC 2A x .187 BHMS NYLON		1
29	LOCKING TERMINAL LUG		5
31	WASHER #8 NYLON FLAT		2

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
AUTOMATCH ASSEMBLY
PM 702-A

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	07694	B		

DRAWN	DATE	SHEET 4 OF 4
B.J.	4-19-82	

0

REV	F
DWG NO.	C 02827

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

F	E.O. #11333 AK	12-81	[illegible]	[illegible]
REV	DESCRIPTION	DATE	CHK	APPR

REVISION LEVEL

NEXT ASSY.

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
R.F. CONDUCTOR
SUB ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	02827	F		

DRAWN	DATE
J.V.	7-5-78

A05495 REV. B

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	R.F. CONDUCTOR	B 02821	1
C210,209	CAPACITOR 100pf, CM 05-ED-K1J03	1500-0117	2
C203	CAPACITOR, 8 TO 8.2 pf, SPRAGUE, SGA-V82	1500-0222	1
L202,203	COIL, 39 uH, J.W. MILLER 9210-56	1800-0012	2
-10	LOCKING TERMINAL LUG, H.H. SMITH 1416-8		8
2	RING TERMINAL-NON INSULATED,12-10 AWG H.H.SMITH 4934		7
3	SCREW, 8-32 UNF - 2Ax3/4 BHMS NYULON		4
4	NYLON SPACER - RND, .25 ODx.25 LG H.H. SMITH 4008	2860-4008	4
5	NYLON SPACER - RND, .25 ODx.187 LG H.H. SMITH 4005	2860-4005	3
CR201-203	DIODE, MOTOROLA IN4151	4800-0045	3
6	WASHER - NYLON - CAE 6000-000		
7	NUT - 8-32 #BAE-0832-0002, 8-32 UNF-2B HEX KEPS NUT		
8	WIRE, 12 GA BUSS WIRE		A/R
9	WIRE, 16 GA BUSS WIRE		A/R

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: R.F. CONDUCTOR SUB ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	02827	F		

DRAWN J.V. DATE 7-5-78

SHEET 2 OF 2

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
C1	AIR VARIABLE CAP	1550-0201	1
	EF JOHNSON 154-513-101		
1	STL EXSPANSION PIN .062 DIA X .50 DP	2860-9001	1
	Mc MASTER-CARR 98296A109		
2	STL EXPANSION PIN .093 DIA X .750 DP	2860-9003	1
	Mc MASTER-CARR 98296A181		
3	GEAR MODIFICATION	B04564	1
4	INTERCONNECTION BRKT	B 03533	2

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: PM 702 & 703
C1 - INPUT CAPACITOR ASSY

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03470	C	[illegible]	[illegible]

DRAWN	DATE	SHEET 2 OF 2
JV	7-7-78	

DWG NO.	REV
B 03471	D

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION	DATE	CHK	APPR
D	JD	4-7-82		

REVISION LEVEL

NEXT ASSY.
A 09290
A 09280
A 06650
D 03139

TITLE: M1 INPUT MOTOR DRIVE ASSEMBLY

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

SIZE	DWG. NO.	REV.	CHK.	APPR.
B	03471	D		

DRAWN	DATE
J.V.	6-28-78

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
3	STL EXPANSION PIN, .062 DIA x .50 LG,	2860-9001	1
	McMASTER-CARR #98296A109		
M1	MOTOR, MICRO MO 3301409-03-2-1734:1	3500-0005	1
2	CLUTCH, STERLING SLIPCLUTCH #MM-2	3500-0015	1
4	GEAR ALUM, STERLING S21A-54	3500-0023	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: M1 INPUT MOTOR DRIVE ASSEMBLY

SIZE	DWG. NO.	REV.	CHK	APPR.
B	03471	D	[illegible]	

DRAWN	DATE	SHEET	OF
J.V.	6-28-78	2	2

A04289 REV B

REV	D
DWG NO.	B 04416

BRANSON INTERNATIONAL PLASMA CORPORATION

ENGINEERING PARTS LIST

REV	DESCRIPTION	DATE	CHK	APPR
C	JD	4-7-82	TK	

REVISION LEVEL

NEXT ASSY.
A 09290
A 09280
A 06650
D 03139

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: M2 OUTPUT MOTOR-DRIVE ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
B	04416	C		

DRAWN	DATE
J.V.	6-28-78

C

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
3	STL EXPANSION PIN, .062 DIA x .50 DP	2860-9001	1
	McMASTER-CARR #98296A-109		
1	MOTOR, MICRO MO 3301409-03-2-975:1	3500-0004	1
2	CLUTCH, STERLING SLIPCLUTCH #MM-2	3500-0015	1
4	GEAR ALUM, STERLING, S21A-54	3500-0023	1

BRANSON/IPC
a SmithKline company

31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE: M2 OUTPUT MOTOR-DRIVE ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
B	04416	C		

DRAWN	DATE	SHEET	OF
J.V.	6-28-78	2	2

A04289 REV B

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
C2	AIR VARIABLE CAP	1550-0202	1
	EF JOHNSON 154-510		
1	STL EXPANSION PIN .062 DIA x .50 DP	2860-9001	1
	McMASTER-CARR 98296A109		
2	STL EXPANSION PIN .093 DIA x .75 DP	2860-9003	1
	McMASTER-CARR 98296A181		
3	INTERCONNECT BRK'T	B 03533	2
4	GEAR MODIFICATION	B 04564	1
	Replaced C03470-002		

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: PIN 702
C2- OUTPUT CAPACITOR ASS'Y

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	04440	B	RHS 8-7-78	

DRAWN	DATE	SHEET
JY	7-7-78	2 OF 2

A 04289 REV B

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	RF COUPLER COVER	B 03257	1
2	RF COUPLER BODY	B 03258	1
3	RF COUPLER CONDUCTOR	B 03259	1
4	NYLON SPACER, .250 THK.	2860-4008	2
	H.H. SMITH #4008		
5	NYLON BHMS	2860-6328	2
	#6-32 x ½"		
C1, C2	CAPACITOR, 1000 MF FEED THRU	1500-0205	2
	ERIE #327-000-X5U0-102M		
J1, J2	UHF CONNECTOR	2180-0190	2
	AMPH #83-798		
R2	RESISTOR, 110 ohm 1 W C.C.	4704-0111	1
R1	POTENTIOMETER	4750-0002	1
	750 ohm A&B TYPE J		
CR1, CR2	DIODE #IN4151	4800-0045	2
6	NYLON #8 WASHER		6
7	#6 SOLDER LUG		2
8	#10 SOLDER LUG		4
9	#318 SOLDER LUG		1
10	#12 GA BUSS WIRE		A/R
11	#18 GA BUSS WIRE		A/R

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: RF COUPLER ASS'Y

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03260	D	A. Rocin 8-4-78	

DRAWN	DATE	SHEET 2 OF 2
	7-12-78	

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	RF COUPLER COVER	B 03257	1
2	RF COUPLER BODY	B 03258	1
3	RF COUPLER CONDUCTOR	B 03259	1
4	NYLON SPACER, .250 THK.	2860-4008	2
	H.H. SMITH #4008		
5	NYLON BHMS	2860-6328	2
	#6-32 x ½"		
C1, C2	CAPACITOR, 1000 MF FEED THRU	1500-0205	2
	ERIE #327-000-X5U0-102M		
J1, J2	UHF CONNECTOR	2180-0190	2
	AMPH #83-798		
R2	RESISTOR, 110 ohm 1 W C.C.	4704-0111	1
R1	POTENTIOMETER	4750-0002	1
	750 ohm A&B TYPE J		
CR1, CR2	DIODE #IN4151	4800-0045	2
6	NYLON #8 WASHER		6
7	#6 SOLDER LUG		2
8	#10 SOLDER LUG		4
9	#318 SOLDER LUG		1
10	#12 GA BUSS WIRE		A/R
11	#18 GA BUSS WIRE		A/R

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: R F COUPLER ASS'Y

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03260	D	A. Rocha 8-4-78	

DRAWN	DATE	SHEET
	7-12-78	SHEET 2 OF 2

DIONEX GAS PLASMA SYSTEMS

ENGINEERING PARTS LIST

DWG. NO.	REV.
B 03690	F

REV	DESCRIPTION	DATE	CHK	APPR
F	REVISED E.O. #11751 MS	12-21-82	XR	DH
E	E.O. #11209 AK	10-81		
D	E.A.R.#20314	9-8-80		
C	E.O. #10535, 10543	5/7/79		

REVISION LEVEL

DIONEX GAS PLASMA DIVISION
31169 SAN BENITO
HAYWARD, CALIF. 94544

DRAWN	DATE	TITLE
K.G.	5/7/79	PM 702, 703 AUTOMATCH CIRCUIT BOARD ASSEMBLY
CHECKED	DATE	
ENG.	DATE	

SIZE	DRAWING NO.	REV.
B	03690	F

NEXT ASSY.

DO NOT SCALE THIS DRAWING

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
6	PRINT CIRCUIT BOARD	02704	1
2	HEATSINK	B 04485	4
C101, 102	CAPACITOR .01uF 500V	1500-0001	2
	SPRAGUE 5GAS-10		
1	DIP SOCKET 14PIN	2110-0001	2
	AMPHENOL 021-2000-144		
R101, 102	RESISTOR CARBON COMP	4702-0153	2
	15K 1/4W		
R121	RESISTOR CARBON COMP	4702-0102	1
	1.0K 1/4W		
R125	RESISTOR CARBON COMP	4702-0103	2
124	10K 1/4W		
R116, 117	RESISTOR CARBON COMP	4702-0154	2
	150K 1/4W		
R109, 110	RESISTOR CARBON COMP	4702-0472	2
	4.7K 1/4W		
R123	RESISTOR CARBON COMP	4702-0473	1
	47K 1/4W		
R120	RESISTOR CARBON COMP	4702-0474	1
	470K 1/4W		
R118, 119	RESISTOR CARBON COMP	4702-0562	2
	5.6K 1/4W		
R107, 115	RESISTOR CARBON COMP	4703-0050	2
	5.1 – 1/2W		

DIONEX
GAS PLASMA DIVISION
31159 SAN BENITO
HAYWARD, CALIF.
94544

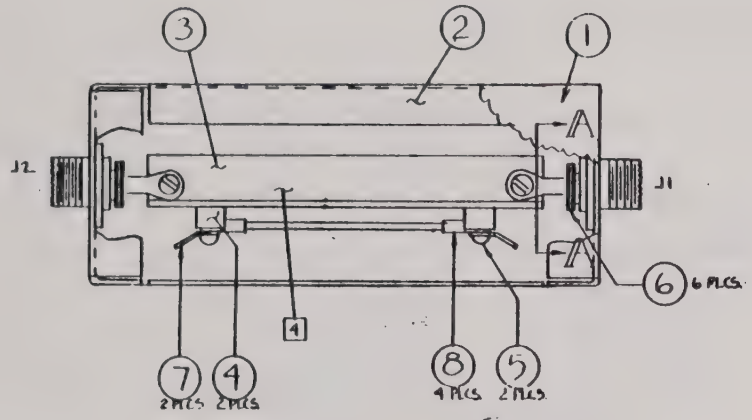
TITLE: PM 702, 703
AUTOMATCH CIRCUIT BOARD ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
B	03690	F		

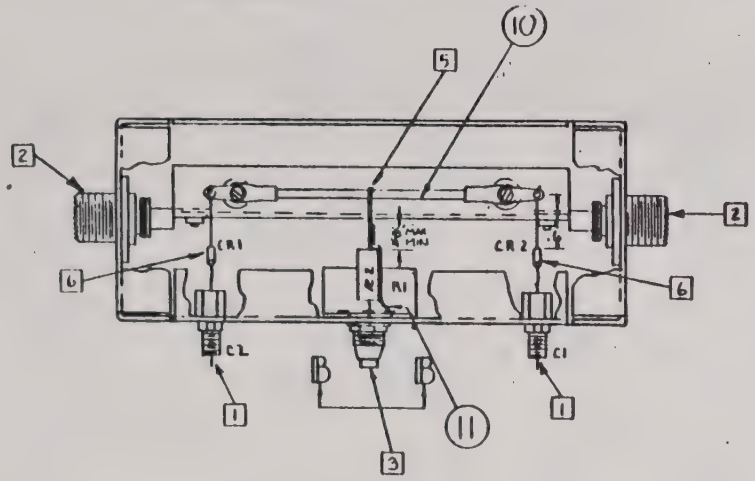
DRAWN	DATE	SHEET 2 OF 3
K.G.	5/7/79	

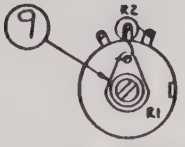
A 04289 REV

REVISIONS				
LTR	DESCRIPTION	PREP	DATE	APPROVED
A	C O# 10234			
B	EO # 10329	JV	4/10/78	DMG
C	REVISED / EO # 10334	JV	6-14-78	PLS PCB
D	EO #10348	SS	7-12-78	MM PCB



VIEW A~A





VIEW B~B

ORDER OF ASSEMBLY

[6] INSTALL CR1, CR2 FROM SOLDER LUGS TO CAPACITORS C1, C2 AS SHOWN

[5] SOLDER FREE END OF R1 AROUND THE CENTER OF THE PICK UP WIRE

[4] INSTALL RF CONDUCTOR ASS'Y INTO COUPLER AS SHOWN

[3] INSTALL RESISTOR ASS'Y INTO COUPLER BODY AS SHOWN

[2] INSTALL CONNECTOR ASS'Y INTO ENDS OF COUPLER BODY

[1] INSERT C1 C2 IN COUPLER BODY

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS DEC ANGLES
± ± ±

APPROVALS	DATE
DRAWN	7/14/78

INTERNATIONAL PLASMA CORP.

RF COUPLER ASS'Y

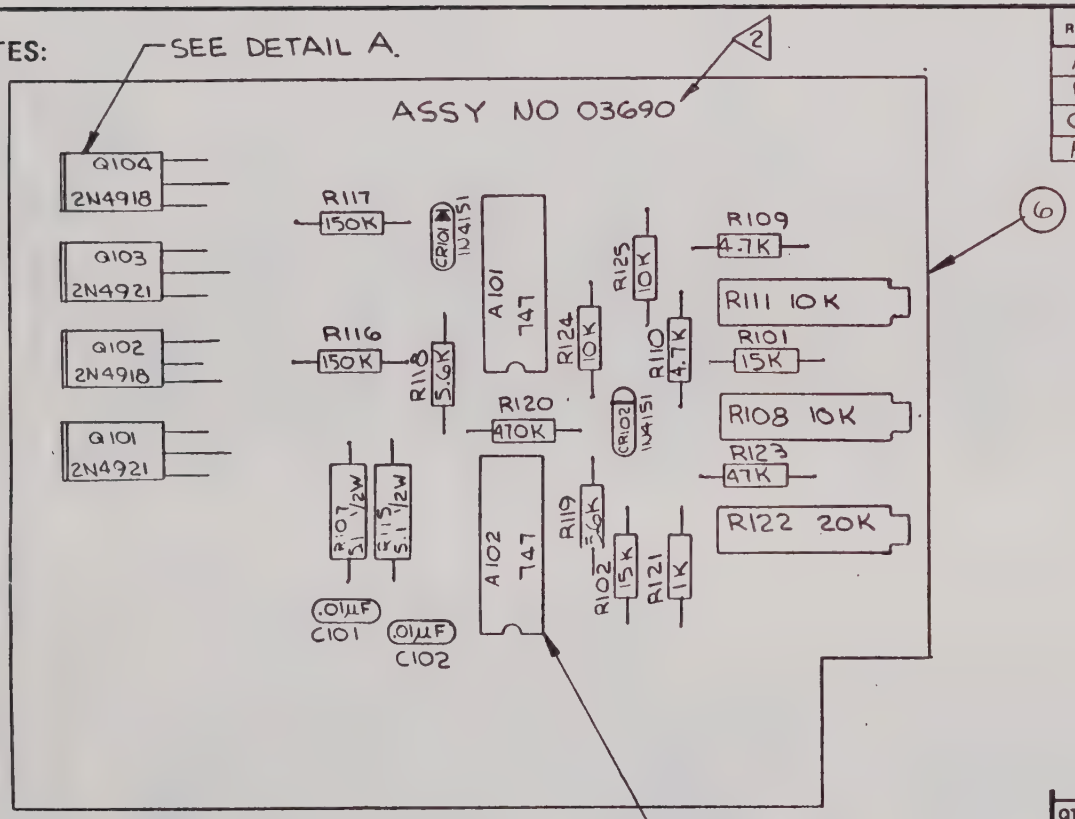
SCALE	SIZE	DRAWING NO	REV.
FULL	C	03760	D

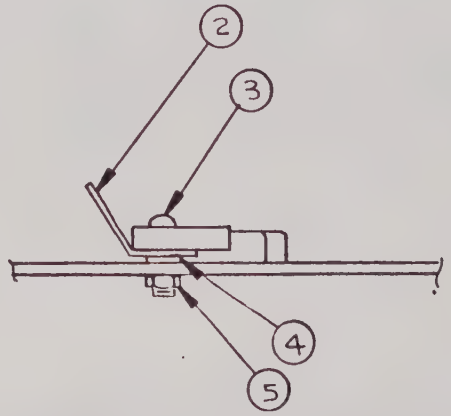
DO NOT SCALE DRAWING — SHEET 1 OF 2

REV	DESCRIPTION	DATE	CHK	APPR
A	EO 10348	10-13-78		
B	EO 10435	1-12-79		
C	EO 10543	5-79		
F	REVISED E.O # 11751 M.S.	3/		DH

NOTES:

SEE DETAIL A.





TRANSISTOR MTG DETAIL
(DETAIL A)

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS 1/4 W, CARBON
2. STAMP: ASSY NO 03690

QTY	ITEM	PART NUMBER	DESCRIPTION

	NAME	DATE
DFT	K. GUINN	10/13/80
CHK		
ENG		12/15

MODEL	NEXT ASSY

FINISH:

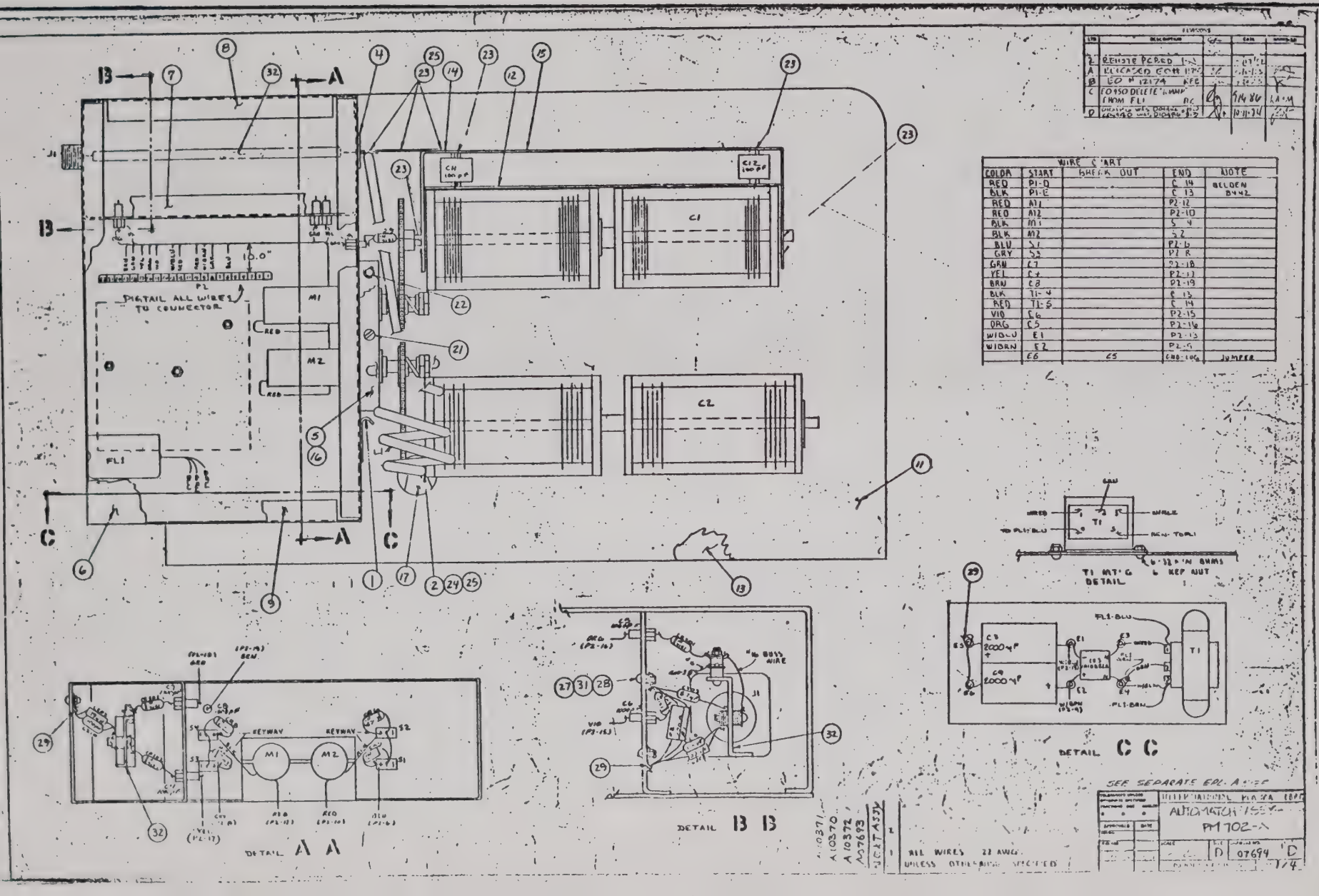
DIONEX GAS PLASMA DIVISION

TOLERANCES UNLESS OTHERWISE SPECIFIED:
.XX ± mm. ± SURF. FIN. ✓
.XXX ± ANGLES ±

TITLE
PM 703, PM 702
AUTOMATCH BD ASSY

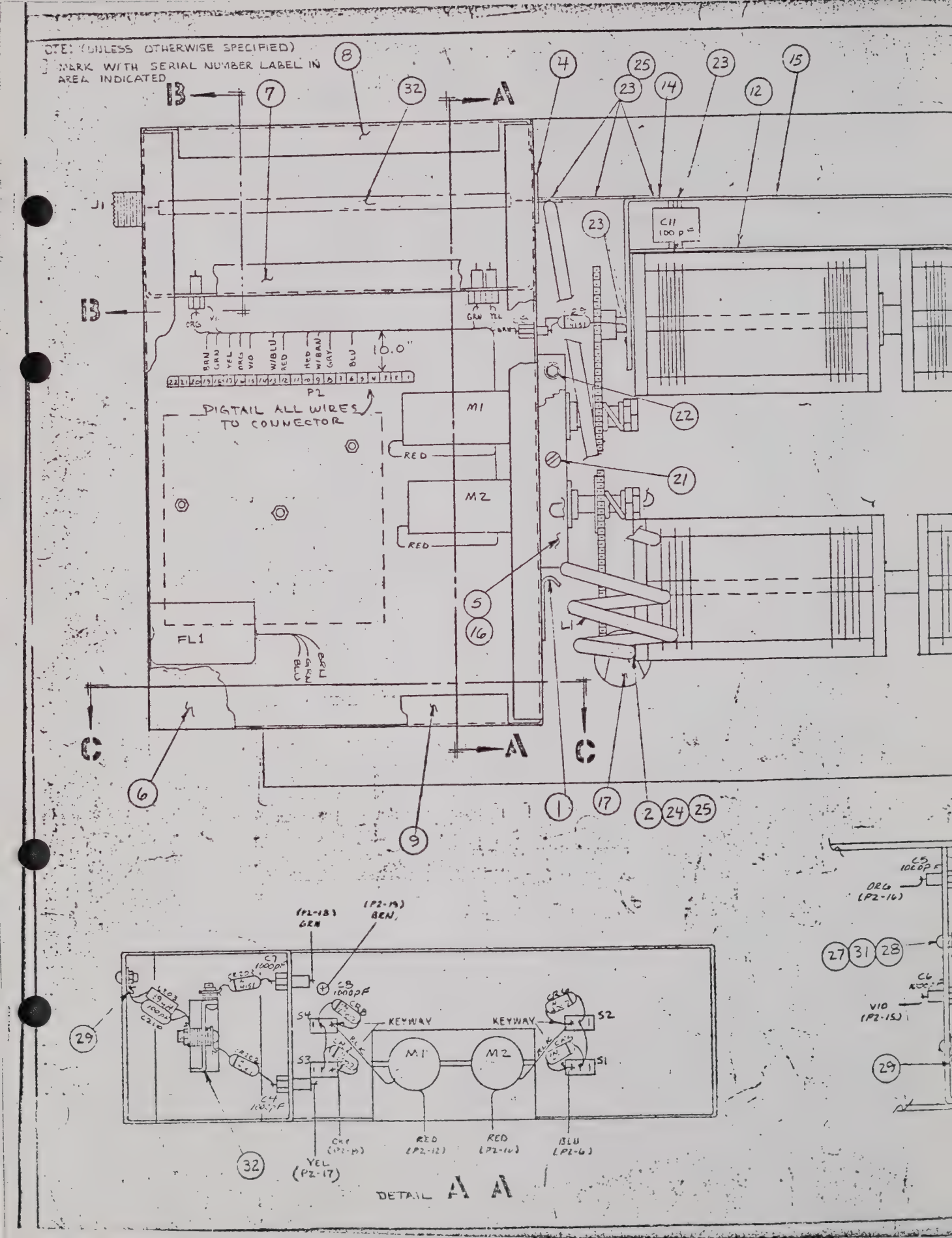
SCALE	SIZE	DRAWING NUMBER	SHT	REV
2:1	B	03690	1 OF 3	F

CAE Drafting 290

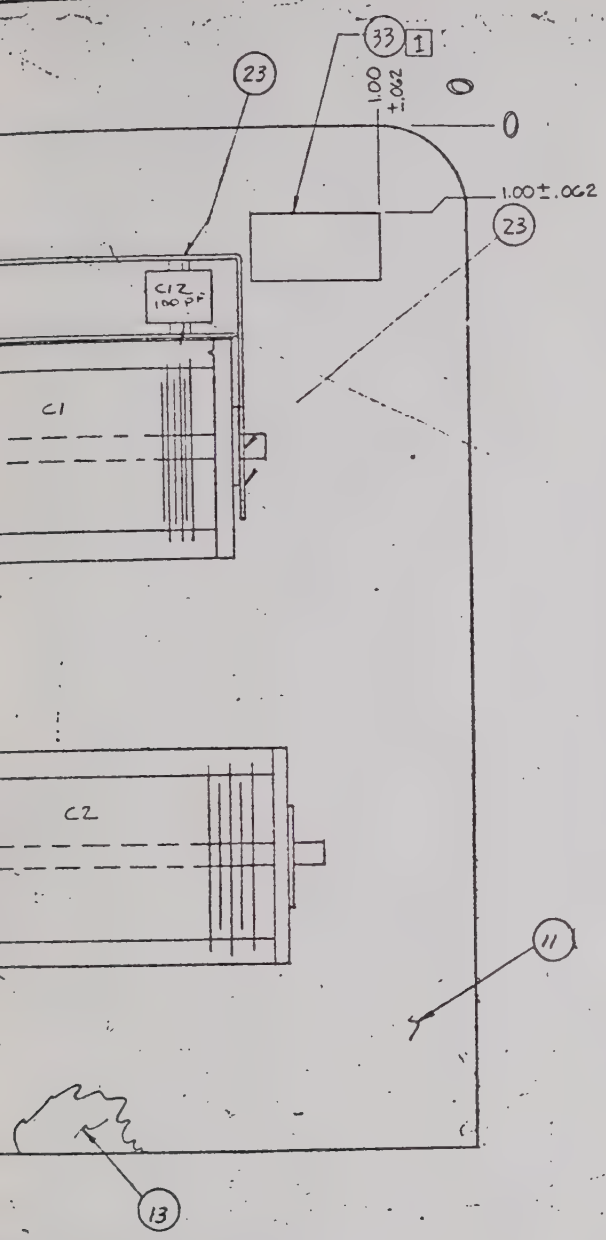


REVISIONS				
LTR	DESCRIPTION	ECO	DATE	APPROVED
E	REMOTE PCBD 1-4		9/7/82	
A	RELEASED FOR PROD		10/1/83	
B	ECO M 12174 REV		1/24/84	
C	F0350 DELETE "JUMP" FROM FL1	DC	9/4/86	LAM
D	CHANGED WIRE COLORS AND DIGITAL P2		10-11-94	

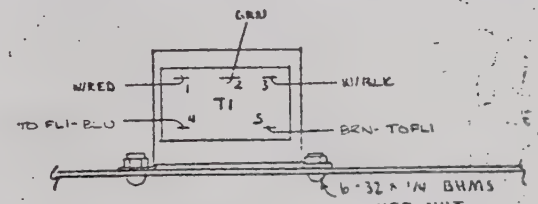
WIRE CHART				
COLOR	START	BREAK OUT	END	NOTE
RED	P1-D		C 14	BELDEN
BLK	P1-E		C 13	B442
RED	A11		P2-12	
RED	A12		P2-10	
BLK	A11		S 4	
BLK	A12		S 2	
BLU	S1		P2-6	
GRY	S3		P2 R	
GRN	E7		P2-18	
YEL	E4		P2-17	
BRN	E8		P2-19	
BLK	T1-4		C 13	
RED	T1-5		C 14	
VIO	E6		P2-15	
ORG	E5		P2-16	
WHBLU	E1		P2-13	
WHBRN	E2		P2-5	
	E6	E5	CAB-106	JUMPER


NOTE: (UNLESS OTHERWISE SPECIFIED)
MARK WITH SERIAL NUMBER LABEL IN AREA INDICATED
J1
P2
PIGTAIL ALL WIRES TO CONNECTOR
M1
M2
FL1
C11 100 pF
10.0"
BRN GRN YEL ORG VIO W/BLU RED RED W/BRN GRY BLU
GRN YEL
RED
BLU GRY BRN
(P2-18) GRN
(P2-19) BRN
C7 1000pF
C8 1000pF
C5 100pF
C6 100pF
C3 100pF
C4 100pF
KEYWAY
S1
S2
S3
S4
ORG (P2-16)
VIO (P2-15)
CR1 (P2-M)
RED (P2-12)
RED (P2-14)
BLU (P2-6)
YEL (P2-17)
DETAIL A A

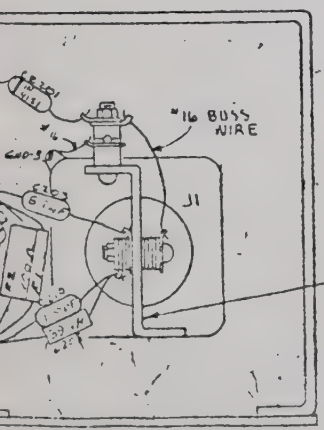
REVISIONS				
LTR	DESCRIPTION		DATE	APPROVED
2	REMOTE PC BRD		3/13/72	
A	RELEASED EO # 11765		5/17/73	
B	EO # 12174 RFE		2/24/73	
C	EO 450 DELETE 10AMP FROM FL RC		9/14/86	
D	E 2486 WAS 2485 E 2487 WAS 2486 E 2485 WAS 2487		12-11-74	
E	ITEM 33 ADDED EO		12-4-86	



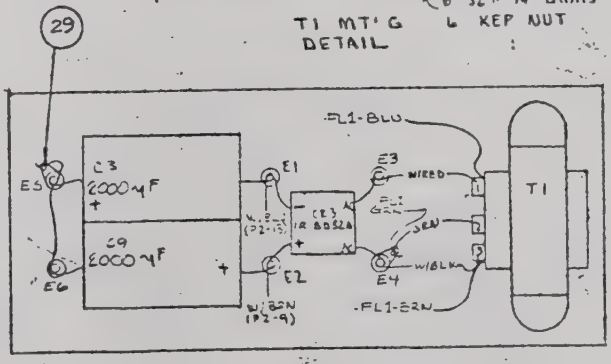
WIRE CHART				
COLOR	START	FROM OUT	END	NOTE
RED	P1-D		C 14	BELDEN 8442
BLK	P1-E		C 13	
RED	M1		P2-12	
RED	M2		P2-10	
BLK	M1		S 4	
BLK	M2		S 2	
BLU	S1		P2-6	
GRY	S3		P2-8	
GRN	C7		P2-13	
YEL	C4		P2-17	
BRN	C8		P2-19	
BLK	T1-4		C 13	
RED	T1-5		C 14	
VIO	C6		P2-15	
ORG	C5		P2-16	
W/BLU	E1		P2-13	
W/BRN	E2		P2-9	
	E5	E5	GND-LUG	JUMPER



T1 MT'G & KEP NUT DETAIL



DETAIL B B



DETAIL C C

SEE SEPARATE ERL-A

NOTES: UNLESS OTHERWISE SPECIFIED			
TOLERANCES ON DIMENSIONS FRACTIONS DEC ANGLES			
APPROVALS	DATE		
DRAWN			
CHECKED			

AUTOMATIC TEST SYSTEMS

PM702-A

SCALE	SIZE	DRAWING NO.	REV
	D	07694	E

DO NOT SCALE DRAWING

1 OF 4

07694
PART 110

NOTES: UNLESS OTHERWISE SPECIFIED			
ALL WIRES 22 AWG.			

NOTES: UNLESS OTHERWISE SPECIFIED			
NOT ASSY			
2	A10371		
1	A10370		
	A10372		
	A07693		

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION

INSTRUCTION MANUAL

for

R. F. GENERATOR PM 119

A03145 Rev C
2/1/78

31172 Huntwood Avenue
P.O. Box 4136, Hayward, CA 94544

INSTRUCTION MANUAL

for

PM 119

Table of Contents

	page
1.0 INTRODUCTION	1
1.1 General Description	1
1.2 Specifications	1
1.3 Equipment Supplied	3
2.0 INSTALLATION	3
2.1 Unpacking and Handling	3
2.2 Installation	3
3.0 OPERATION	3
3.1 Controls and Indicators	3
3.2 Operation	5
4.0 THEORY OF OPERAION	6
4.1 Functional Description	6
4.2 Circuit Description	6
4.2.1 Power Amplifier	7
4.2.2 Coupler	8
4.2.3 Oscillator	8
4.2.4 Regulator	9
4.2.5 Vacuum Circuit	10
4.2.6 Vacuum Trioger	11
4.2.7 5 Torr Detector	11
4.2.8 Power Supply	11
5.0 MAINENTANCE	
5.1 Packaging	12
5.2 Preventive Maintenance	13
5.3 Alignment	13
5.4 Calibration	15
5.4.1 Power Meter	15
5.4.2 Torrmeter	16
5.4.3 Vacuum Trigger	17
5.4.4 5 Torr Detector	17

2-1-78

1.0 INTRODUCTION

1.1 General Description:

The PM119 RF Generator provides the necessary radio frequency power to generate a plasma in either the 8000 series or 2000 series plasma systems. It includes circuits which measure characteristics of the plasma in the reaction chamber, with provisions to drive meters remotely located in the system controller.

The metered quanitities are the RF (radio frenquency) power level transmitted to the chamber; the reflected power, indicating any impedance mismatch between the chamber impedance and 50 ohms; and the pressure of the gas in the chamber.

The output power level is continously controlled over the full 500 watt range by a remote knob. The output level is regulated to withstand normal line voltage variations about 117 volts at either 50 or 60 hertz.

The frequency of the output is crystal controlled at 13.56 Megahertz. The output is designed to drive a 50 ohm load.

The PM119 also includes provisions for initiating the process cycle in an 8000 series controller. It detects that the reaction chamber has been evacuated to a preset level (aproximately 0.2 torr) and transmits a signal to the controller which then begins the process cycle.

1.2 Specifications:

Output Frequency.....	13.56 Mhz ±0.005%, crystal controlled
Output Power.....	0-500 watts with continous control
Output.....	Designed for 50 ohm load
Output Connector.....	Type UHF
Power Monitor.....	Output DC current is provided to drive an external meter which is calibrated to a full scale

1.2 (con't)

Power Monitor (con't).....reading of 500 watts. Two seperate outputs give the power transmitted to or reflected from the load.

Vacuum Monitor.....A calibrated DC current is provided to drive a remote meter which is scaled from 0.1 to 20 with a shaded region to indicate atmospheric pressure. The signal drive to the meter is brought in from outside the PM119, being generated by a vacuum transducer in the treatment console.

Power Control.....A remote rotary control knob continously varies power from zero to maximum. A remote toggle switch may switch the RF output on or off. A front panel AC line switch turns power of the PM119 on or off.

WARNING! WHEN OPERATING THE AC POWER SWITCH FROM ON TO OFF, THE OUTPUT POWER MUST BE AT A MINIMUM. EITHER THE LEVEL CONTROL MUST BE AT A MINIMUM SETTING, OR THE RF ON/OFF SWITCH MUST BE OFF.

Rear Panel Connections.....A permanently attached three-wire power cord is provided at the rear panel. A rear connector provides A.C. Power, metering signals, interlock wires, and control wires to the system programmer. A second connector provides power to and receives the signal from the vacuum transducer. A third connector provides RF output.

Power Requirements.....117 volt nominal AC, 50-60 Hz, 15 Amp, maximum. Requires normal three-wire input with ground, neutral and 117 volt leads.

Dimensions.....Width 21 inches
.....Height 11 inches
.....Depth 16.5 inches

Weight.....75 lbs.

1.3 Equipment Supplied:

The following equipment is supplied with the PM119 Control Console:

1 RF Power Output Cable IPC# 01163-001
1 Programmer Cable IPC# 02351-001
1 Vacuum Transducer Cable IPC# 02492-001

2.0 INSTALLATION:

2.1 Unpacking and Handling:

The IPC PM119 Control Consoles are thoroughly tested and inspected and then carefully packed before shipment. The unit should be unpacked with the care due any precision instrument. If the package shows that it has been dropped or handled roughly, return it to the carrier unopened.

Remove the packing carton, being careful not to scar or damage the unit. Make a complete visual inspection of the equipment, checking for damage or missing components. Check that all switches and controls operate mechanically. Report any damage immediately to your IPC representative.

2.2 Installation:

No special installation instructions are required for the PM119 other than those required if special peripheral equipment is required. Mount it as close as possible to the RF power load and leave clear space at the back of the instrument to allow air flow. The PM119 is attached to the RF load with the supplied RF power output cable. If the PM119 is used in a standard IPC Plasma Generation System, Vacuum Transducer and Programmer cables may be used directly. Their connections will be explained in the manual for the system. Connections to other equipment must be taken up as special cases. Information must be obtained from a IPC representative or from reference to the schematic.

BE SURE TO REMOVE SHORTING WIRES ON METERS IN GENERATOR BEFORE OPERATION!

3.0 OPERATION:

3.1 Controls and Indicators:

The operating controls and indicators of the PM119 are located on the front panel. The connectors are

3.1 (con't)

on the rear panel. In the text, all operating controls are called out as they appear on the equipment. Front panel controls and rear panel connectors are described in the following table:

Front Panel Controls and Indicators

AC POWER ON/OFF Switch.....Applies AC power to the PM119

WARNING! WHEN OPERATING THE AC POWER SWITCH FROM ON TO OFF, THE OUTPUT POWER MUST BE AT A MINIMUM. EITHER THE REMOTE LEVEL CONTROL MUST BE AT A MINIMUM SETTING, OR THE REMOTE RF ON/OFF SWITCH MUST BE OFF.

AC POWER Indicator.....The lamp above the AC POWER switch lights when the AC POWER is ON.

READY Indicator.....The lamp lights when RF power is available. Approximately 3 minutes after the AC POWER has been turned on.

Rear Panel Connectors

AC Power Cord.....A permanently attached three-wire cord through which the PM119 obtains its line power.

VACUUM TRANSDUCER Connector.....Allows the vacuum transducer which drives the vacuum meter to be attached to the PM119. It supplies power to the transducer and couples the return signal to the meter.

PROGRAMMER Plug.....This connects the PM119 to the remote controls which normally determine the PM119 output. 117 VAC is sent to the remote unit. A control line to an external potentiometer determines the PM119 output power level. Three sets of meter leads drive an external vacuum meter and forward and reflected power meter. A power interlock lead may be used to interrupt R.F. power from the PM119. An output denoting a preset vacuum level is provided.

3.1 (con't)

RF POWER OUTPUT.....Connects PM119 output power to the load via UHF type connector.
Connector

3.2 Operation:

Instructions in this section apply to operation of the PM119 independently as a source of RF power. Operation in complete IPC Plasma Systems is described in the manual which applies to that particular machine. Sufficient instructions are included here to operate the PM119 as a power source to supply energy into a 50 ohm matched load.

Since power from the PM119 is controlled via the Programmer cable, either appropriate auxiliary equipment must be provided which includes the RF control or a special control must be constructed. This may be simply a 100K, 2W potentiometer connected to pins L, J, and K of the PROGRAMMER jack. Fasten the wiper to pin J and the end of the pot contacted by the wiper in full clockwise rotation to pin K.

Operating Procedure

1. Attach the RF power output cable to the power output connector on the rear panel of the PM119 and couple the 50 ohm load to the other end of the cable.

2. When the PM119 is used in a complete IPC plasma system, the Programmer cable and Vacuum Transducer cables are installed. As it is here being used separately, install the special RF control discussed above. No RF power can be obtained without some connection to the Programmer jack.

3. Set the AC and RF POWER switches to OFF, the RF POWER LEVEL control full counterclockwise, and the FWD/REFL switch to FWD.

4. Plug the three-wire power cord into the appropriate power outlet socket.

5. Allow the PM119 to warm up 3 minutes with the AC POWER switch ON before operating any other controls. If the PM 119 is used in a complete IPC PLASMA machine evacuate the Reaction Chamber to a pressure of 2 torr.

6. After the unit is warmed up, the READY indicator will kight. Turn the RF POWER switch to ON.

7. Raise the RF LEVEL control until RF output is obtained If the PM 119 is used in an IPC PLASMA System, the power may be read on the wattmeter provided in the system. If it is used separately, an external inline

3.2 (con't)

7. (con't) wattmeter must be provided between generator and load.

8. Rotate the RF POWER LEVEL control clockwise until the wattmeter reading moves up the scale.

9. With the wattmeter reading about 50 watts, change the FWD/REFL switch to REFL. With a matched 50 ohm load, this reading should be very small. If it is large, more than 10-15 watts, then the load must be matched to bring the reflected power down. If the PM119 is used in a standard IPC Plasma System further instructions on matching will be contained in the manual for that system. If not, other means must be used to bring the load to a matched condition.

10. When the load is matched, the power may be raised to any value up to maximum. Return the FWD/REFL control until the wattmeter reads the desired power output.

11. Check the reflected power by switching the FWD/REFL switch to REFL, to be sure that the load remains matched. Reflected power should be less than 2.0% of the forward power. Power must be reduced <u>if the match</u> is not maintained.

WARNING: WHEN OPERATING THE AC POWER SWITCH FROM ON TO OFF, THE OUTPUT POWER MUST BE AT A MINIMUM. EITHER THE LEVEL CONTROL MUST BE AT A MINIMUM SETTING, OR THE RF ON/OFF SWITCH MUST BE OFF.

4.0 <u>THEORY OF OPERATION</u>

4.1 <u>Functional Description</u>:

A functional block diagtam of the PM119 is shown in Fig.1. The OSCILLATOR, POWER AMPLIFIER, COUPLER and REGULATOR constitute a feedback control system regulating the output power at a level determined by the RF level control located on the front panel of the PM119 Generator. The OSCILLATOR generates a 13.56 mhz sine wave which is amplified by the POWER AMPLIFIER. The amplitude of the OSCILLATOR'S output is controlled by the REGULATOR. The COUPLER detects the power supplied by the POWER AMPLIFIER and outputs a dc signal proportional to the power. This dc signal is fed to the REGULATOR where it is compared with the setting of the remote power level setting.

The POWER AMPLIFIER is designed to drive a resistive fifty ohm load, and the reactor center input circuitry is designed to present a fifty ohm load to the generator. This

4.1 (continued)

constitutes a "matched' modular system. In order to provide the appropriate fifty ohm impedance each Reactor Center includes a "matching network" which transforms the impedance of the plasma chamber to fifty ohms. This network must be adjusted to accomodate each set of operating parameters of the Reactor Chamber, e.g; power, pressure, gas. The adjustment of the matching network may be either manual or automatic, depending upon the option provided in the Reactor Center. However, during the time that the matching network is being adjusted, a mismatched condition exists which is a potential hazard to the output stage of the POWER AMPLIFIER. To prevent possible damage to the generator, the COUPLER detects the degree of "mismatch" and provides a DC signal proportional to the mismatch. This signal is referred to as "reflected power", and is fed to the REGULATOR. If the reflected power exceeds a preset limit, the REGULATOR automatically limits the output power to a level that is safe.

The VACUUM CIRCUIT provides the power required by the vacuum sensor in the Reactor Center, and provides the appropriate interface between the sensor and the vacuum display or mater. The VACUUM TRIGGER detects a preset vacuum level and transmits a signal to the Reactor Center (8000 Series). The 5 torr detector circuit disables RF when a pressure greater than 5 torr is detected in the Reaction Chamber. Operating the system at greater pressure may result in damage to the Reactor Center "matching network". The power supply generates the DC voltages required by the system.

4.2 Circuit Description: Refer to Schematic D03035

4.2.1 Power Amplifier:

The power amplifier utilizes a single vacuum tube tetrode V1, which is connected in a common cathode configuration. Capacitors C6 and C7 with inductors L1 and L2 constitute a two section filter to attenuate the RF to the high voltage power supply. Capacitors C14, C15, and C16 provide AC ground to the screen grid of the power tube. C17 is an RF bypass for the filament. An RF voltage is fed to the control grid from the oscillator, and the resulting amplified plate signal is coupled to a pi matching network through C13. The RF signal and the superimposed DC bias fed to the grid of the power amplifier bear the proper relationship and the amplitude to drive the amplifier class C

The pi matching network transforms the load impedance

4.2.1 (con't)

normally fifty ohms, to a higher impedance appropriate for the plate circuit of the tetrode. It is composed of capacitors C9, 10, 11, 12, 18, and 19 with inductor L3. The output of the pi filter is shunted by inductor L4, which serves as a bleeder and filter to power supply ripple frequencies. The variable inductor L3 is the means for adjusting or tuning the plate circuit to the oscillator frequency, while variable capacitor C12 provides means for adjusting the efficiency of the power amplifier class C stage.

Variable capacitor C17 is a neutralizing capacitor, and feeds back a small fraction of the RF plate voltage to the oscillator output circuitry. There it is added out of phase with the oscillator signal to effect the neutralization.

Resistor R112 is a voltage dropping resistor for the screen, and voltage across it serves as a measure of the screen current. Fuse F1 limits the screen current to a safe value. The fuse is readily accessible on the front panel.\

4.2.2 Coupler

The RF Coupler receives the signal from the power amplifier, and with minimal loss couples it to the output cable. It also generates dc signals representative of the power coupled to the output and of the impedance mismatch between the actual load and the desired 50 ohms. These two dc signals are fed to the regulator.

4.2.3 Oscillator

The oscillator is a single stage tuned plate-tuned grid vacuum tube oscillator. The frequency controlling element is a 13.56 mhz crystal, X301 in the grid circuit. R301 provides a dc path for the control grid current, as the grid bias is class C. The plate tuned circuit is comprised of inductor/transformer L303 and capacitors C305, C306m and C307. Variable capacitor C306 provides the means for adjusting the frequency of the plate circuit to crystal frequency. L303 also serves as an autotransformer which transforms the impedance of the power amplifier grid circuit to a higher impedance appropriate for the plate of the oscillator tube. Also L303 with resistors R304 and R305 complete the path for neutralizing the power amplifier tube. R310 and C311 comprise an

4.2.3 (con't)

attenuator and phase shift network completing the feedback loop for the oscillator. C308 provides ac ground for the plate circuit. R302 with bypass capacitor C301 provide a means for monitoring the oscillator tube current at TB2-1 through an isolation resistor R303. The 450 volt plate supply is fed to the plate through L302. L302 and C312 filter the RF to the supply.

The amplitude of the OSCILLATOR output is determined by the positive dc voltage on the screen grid of the oscillator tube. This control voltage is supplied to the OSCILLATOR at terminal E303 by the REGULATOR. A resistive load and voltage supply for the REGULATOR output is provided by the resistor divider R309, R306, R307, R308, and R6. The resistor string is connected between +250 volts at the top and -250 volts at the bottom. The divider also offsets the dc voltage provided by the REGULATOR to bias the control grid of the POWER AMPLIFIER. Transistor Q301 buffers the bias voltage and supplies it to the POWER AMPLIFIER through a filter, L304 and C309, and through L303. Diode CR301 prevents the bias voltage from going too far in the positive direction thereby protecting the POWER AMPLIFIER tube. Capacitors C302 and C303 provide RF bypassing for the screen grid of the OSCILLATOR.

4.2.4 Regulator

The REGULATOR performs two functions. It monitors the power level through the coupler and controls its level according to the setting of the remote RF LEVEL control. It also monitors the "reflected power" from the COUPLER, and if it exceeds a preset level the REGULATOR automatically limits the drive to the POWER AMPLIFIER to a safe level.

Referring again to the schematic, the power level controller consists of operational amplifier A201, buffer transistor Q201, and associated circuitry. The dc signal from the COUPLER is fed through LC filter L201 and C201. This filtered voltage drives the wattmeter through R203. Rheostat R2 serves to calibrate the meter for "forward power". R205 provides a load for the coupler output in the absence of a meter.

The dc gain of the control loop is provided in two parts: The integrated amplifier A201 which

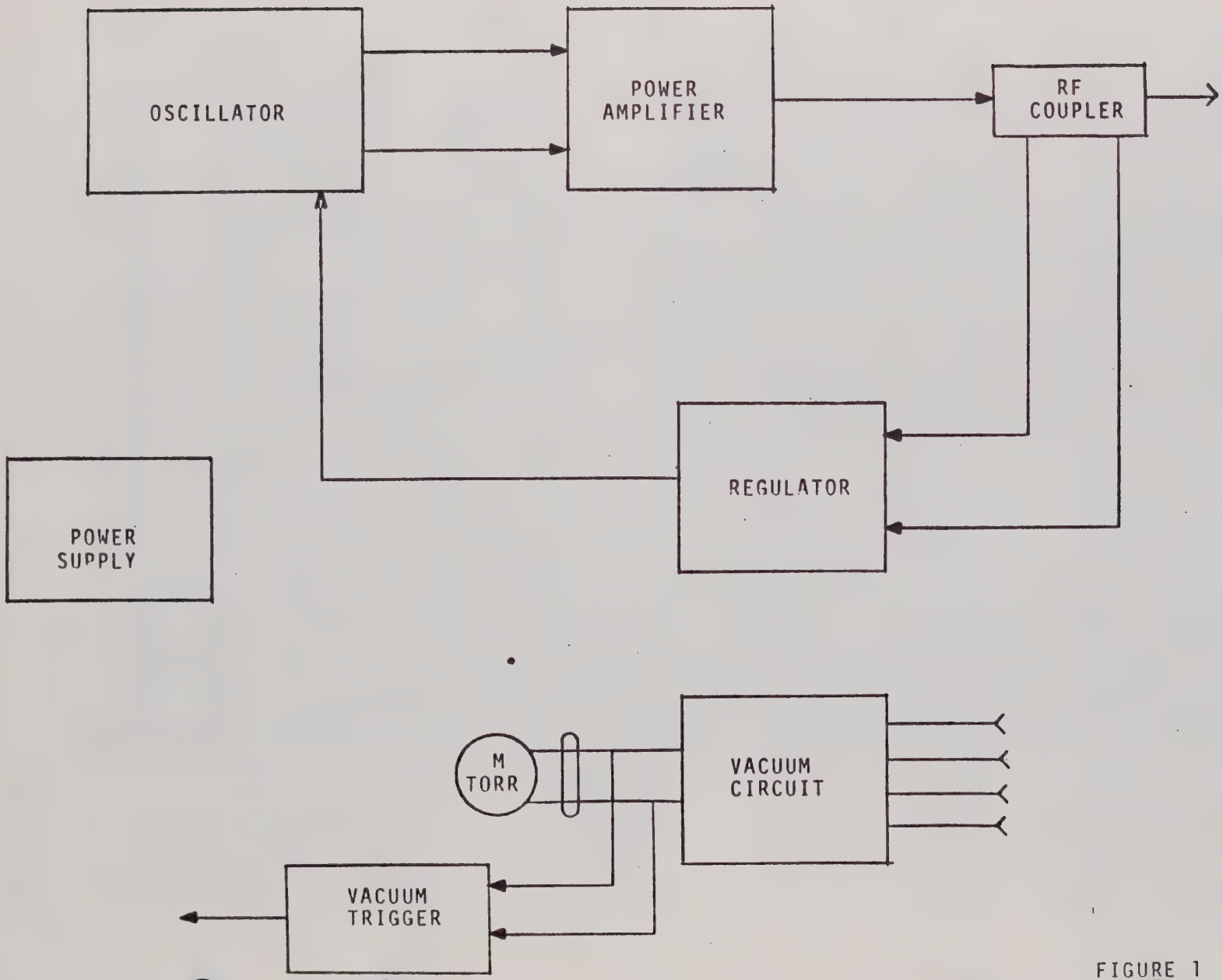

OSCILLATOR
POWER AMPLIFIER
RF COUPLER
REGULATOR
POWER SUPPLY
M TORR
VACUUM CIRCUIT
VACUUM TRIGGER

FIGURE 1

4.2.4 (con't)

has a gain in the order of 10^6: and the amplifier comprised of transistor Q201 and resistors R211 and R213, with a gain of 22. The entire amplifier is made an integrator with feedback capacitor C207 and input resistors R201, R220, R217 and R1. The reference voltage for the amplifier is signal ground through R207. Operationally the regulator output provides a positive voltage to the oscillator grid causing an RF signal through the coupler such that the positive polarity "forward power" signal exactly balances the negative voltage set up by the remote RF LEVEL control.

Capacitors C203, C211 and C209 insure dynamic stability for the feedback amplifier. The output of the integrated amplifier is prevented from going more negative than -5 volts by a clamping network comprised of CR204, CR201, and R209.

The amplifier comprised of integrated amplifier A201 and Q202, with their associated circuitry, perform the identical function as described above, except that it deals with the "reflected power" from the coupler. Its output is combined with the output of the forward power amplifier so that either can limit the RF power output.

If the magnitude of the "reflected power, a positive voltage, exceeds the magnitude of the negative voltage, set by R218, the amplifier shuts down the oscillator by decreasing the oscillator screen voltage.

4.2.5 Vacuum Circuit

The vacuum transducer, which is located in the reactor center remote to the generator, is a thermocouple type. It requires a power source to power its heaters and a meter to display the voltage of its thermocouple. The power source is located in the generator, while the meter is located in the system programmer.

The transducer power source is the vacuum circuit oscillator comprised of integrated circuit amplifier A401 and surrounding components. R401, R402, R403, C402, and C403. The oscillator generates a square wave at approximately one kilohertz. The amplitude of the square wave is adjusted with R4 and coupled to the transducer through transformer T401. The transducers thermocouple is then applied to the remote meter.

4.2.6 Vacuum Trigger

Some plasma system controllers, e.g. 8000 series, require the detection of a preset vacuum level. In the PM 119 this level is preset by R5. The signal is detected by the DC amplifier comprised of integrated circuit amplifier A401, transistor Q401, and their associated circuitry.

The voltage of the transducer thermocouple is applied to one input terminal of the amplifier and the voltage determined by R5 to the other. If the voltage of the thermocouple exceeds the potentiometer voltage, indicating that the chamber pressure is below the preset level, transistor Q401 is turned off. The voltage divider of the R10 and R407 with the +250 volt supply provide the appropriate drive for the relay located in the reactor controller.

4.2.7 5 Torr Detector Circuit

If the PM 119 is used with a complete IPC PLASMA machine, the 5 torr detector circuit inhibits RF when Reactor Chamber pressure is greater than 5 torr. Otherwise excessively high voltages occur in the Reactor Center "matching network" which could damage the network. The vacuum level signal is detected by the DC amplifier comprised of the integrated circuit amplifier A402, transistor Q402, and their associated circuitry. The voltage of the vacuum transducer thermocouple is applied to one input terminal of the amplifier, and the voltage determined by R414 to the other. If the voltage of the thermocouple is less than the potentiometer voltage, Q402 is turned ON. The screen grid of V101, the oscillator tube, is then shunted to ground and RF is inhibited.

4.2.8 Power Supply

The power source for the PM 119 is nominally 117 volts at 50-60 Hz. Referring to the schematic, S1 switches the input power and also provides overload protection. DS1 is the lamp indicating that power is being applied to the unit. B1 is the blower which provides positive air cooling. Transformer T1 provides all the necessary AC voltages utilized in the power supply. Winding S2 drives the filament of the power amplifier tube directly, and winding S4 drives the filament of the oscillator tube. Winding S1 provides the high voltage AC for the power amplifier plate supply. Its output is received by the diode

4.2.8 (continued)

bridge made up of the 20 diodes (five per leg) CR105-CR124. Capacitor C5 is a filter reducing the 100-120 Hz. ripple, and resistors R117-R121 provide a bleeder path for the supply. Winding S3 of T1 provides the AC voltage for generation of all other DC supplies. The negative 250 volt supply is developed by the full wave rectifier/filter comprised of CR126, CR125, and C2. R116 is a bleeder path for the supply. Similarly the positive 250 volt supply is developed by the full wave rectifier/filter comprised of CR102, CR104, and C1. R115 is the bleeder resistor.

The positive 450 volt supply is generated by a voltage doubler arrangement wherein the 250 volt supply is supplemented by a rectifier/filter CR103, C103, CR101, and C104. The bleeder resistor is R114. The two 12 volt supplies consist of zener diodes CR1 and CR2 with resistors R7 and R8. The positive 250 volts is applied to the system through the contacts of time delay relay K1, providing approximately three minutes for the filaments of the power tube to heat before it is called upon to deliver RF. DS1 is a front panel lamp indicating that the warm-up time is over. R13 is a current limiting resistor for the lamp. The output of the plus 250 volt supply is also fused by F1 to prevent overheating of the power amplifier screen grid. If the fuse chould open, it also removes the 250 volts from the screen grid of the oscillator and thereby turns off the oscillator.

5.0 MAINTENANCE

5.1 Packaging

The PM 119 is partitioned into three parts as follows:

1) A lower partition, which becomes accessible upon removal of the bottom cover.
2) A front partition, which becomes accessible upon removal of the hood and front portion of the top cover.
3) A rear partition, which becomes accessible upon removal of the hood and rear portion of the top cover.

All those adjustable components involved in alignment of the generator are included in the lower partition. Each adjustable component is accessible through an access hole in the front or rear panel, or by removing the bottom cover. The lower partition includes two circuit boards. The first contains the circuitry of the RF OSCILLATOR and is bolted directly to the chassis. All of the oscillator parts, except the vacuum tube, are mounted on the

5.1 (con't)

bottom side of the circuit board. The vacuum tube is accessible by removing the top rear cover.

The second circuit board is a plug-in board which houses the circuitry of the REGULATOR, the VACUUM CIRCUIT, and the VACUUM TRIGGER. Adjustments on this circuit board include the FORWARD POWER LIMIT and the REFLECTED POWER LIMIT. They are accesable through an access hole in the rear panel.

The front partition houses the several power resistors, R7, R8, R10, R11, and R12; the power supply filter capacitors C1 and C2; and the front panel parts.

The rear partition includes the circuitry for the RF POWER AMPLIFIER and the voltage supplies. The rectifier diodes with filter capacitors C103 and C104 are packaged on a circuit board which is mounted on top of the power supply transformer T1.

All connectors for mating with other system components are located on the rear panel.

For precise location of parts refer to drawing D03100.

5.2 Preventive Maintenance

The most obvious requirement for preventive maintenance is cleansing the air filters mounted on the rear panel. They are aluminum mesh and can be cleaned with ordinary solvents. If they are not cleaned , restricted air flow could result in damage to the power amplifier tube. The cooling fan requires no lubrication.

5.3 Alignment

As stated previously, all adjustable components are accesible through the front and rear panels, or by removing the bottom partition, it is most convenient to set the generator on the side nearest the ac power ON/OFF switch.

As discussed in Section 3.2, the PM119 is controlled via the PROGRAMMER cable. Consequently, the controls necessary to perform the following adjustments must be provided in the manner indicated in Section 3.2. The PM119 may either be installed in a system, such as an IPC 2000 series system, which includes the necessary control circuits, or a special control must be provided.

5.3 (con't)

Make certain the AC power switch is OFF and the AC power cord disconnected. Remove the botton cover.

Disconnect the 6 volt filament drive [orange wire) by disconnecting the insulated slip-connector in the 6 volt line adjacent to the oscillator board.

Make the following initial adjustments:

1) Bias level (R6) - Mid position.
2) Oscillator tuning capacitor (C306) - Mid position.
3) Plate tuning Capacitor (C12) - Mid position.
4) Plate coil (L3) - fully out, then in three complete turns.
5) Forward limit (R217) - Full counter clockwise.
6) Reflected limit (R218) - Full Counter clockwise.
7) Neutralizing capacitor (C17) - Fully out, then in two full turns.

Turn the RF POWER LEVEL control to its minimum (fully counter clockwise) position.

Set the RF POWER ON/OFF switch to its OFF position.

Plug in the A.C. Power cord.

Turn the A.C. power switch on.

Wait approximately three minutes at which time the READY light will turn on.

Set the R.F. POWER ON/OFF switch to its ON position.

Observe the output of the generator at the RF connector with an oscilloscope. If an oscilloscope is not available, a detector and dc meter may be used.

Observe the voltage on TB2-1 and slowly turn the RF LEVEL control clockwise for a voltage of 4.0 to 5.0 volts. (level control will be sensitive since the circuit is operating open loop without feedback from the RF coupler).

Adjust the oscillator plate tuning capacitor, C306, for a minimum voltage on TB2-1.

Connect a dc voltmeter, e.g. Simpson 260, from TB2-2 to ground. The voltage to be measured here represents the power amplifier plate current, and will be about 0.4 volts.

Connect a dc voltmeter from TB2-1 to ground. The voltage to be measured here represents the oscillator tube cathode current, and will be about 4.6 volts.

Observing the output of the generator, adjust the neutralizing capacitor C17 for a voltage null at the output.
Return the POWER LEVEL control to its minimum position.
Turn OFF the RF ON/OFF switch.

5.3 (con't)

Turn OFF the A.C. POWER switch.

Reconnect the filament lead slip-connector.

If the system wattmeter has not been calibrated, insert an in line wattmeter, e.g. a Thruline Model 43 wattmeter from Bird Electronic Corporation with a 500 watt plug, between the generator RF output connector and a 50 ohm dummy load. The dummy load should be rated for a continous drive of 1000 watts.

Put the A.C. POWER switch to its ON position. After the READY light comes on, turn on the RF ON/OFF switch. Adjust the POWER LEVEL-- control for about 150 watts at the output. Observe the voltage at TB2-2, and adjust L3 for a minimum.

Increase the setting of the POWER LEVEL control for an output power level of 500 watts.

Observe the voltage on TB2-2. Adjust L3 for a minimum and note the minimum value. Adjust C12 so that the minimum value is negative 0.4 volts.

Observe the voltage on TB2-1. Adjust C306 for a null and note the null value. Adjust R6 for a of 4.6 volts.

5.4 Calibration (Do not perform calibration unless 5.3 has been done

5.4.1 Power Meter

Calibration of the system power meter requires a reference meter, e.g. the Thruline Model 43, and a 50 ohm load. If a dummy 50 ohm load is not available, it is feasable to use a reactor center properly matched. An IPC reactor center with AutoMatch would suffice. Using a clip lead, ground J3 pin 8 of the regulator printed circuit board. Insert the reference meter between the generator and the dummy load. Place the FWD/REFL switch in its FWD position, the RF LEVEL OFF and the AC POWER ON. Adjust the mechanical zero of the front panel power meter to read zero (0).

Turn the FWD LIMIT (located on the plug in the circuit board) potentiometer to its extreme counterclockwise position. With the POWER LEVEL control completely counterclockwise turn the POWER LEVEL switch ON.

5.4.1 (con't)

Slowly advance the POWER LEVEL control to extreme clockwise position. The output power should remain at zero. Adjust the FWD LIMIT potentiometer until the reference meter reads 500 watts.

Turn the POWER LEVEL control counterclockwise until the reference meter reads 500 watts. Adjust R2, FWD CAL, so that the front panel meter also reads 500 watts.

Adjust the RF LEVEL control for zero (0) watts and turn the RF OFF. Disconnect the RF cable from the generator output connector. Turn the REFL LIMIT potentiometer to its extreme counterclockwise position.

Turn the RF LEVEL ON, and turn the LEVEL control slowly to its maximum clockwise position. The RF output should remain at zero (0). Adjust the REFL LIMIT potentiometer until the meter reads 50 watts. Put the FWD/REFL switch to its REFL position. Adjust the REFL CAL potentiometer until the meter reads 50 watts on the "reflected power" scale. Remove the clip lead from J3 pin 8.

5.4.2 Torrmeter

The torrmeter adjustment is one which must be made in conjunction with the vacuum transducer which is to be used with the torrmeter. The transducer is normally located remotely in a unit external to the generator. In addition to the system transducer, another reference transducer/meter combination is needed on the same vacuum system. There also must be a means for adjusting the vacuum in the system.

If these conditions can be met, set the system pressure (utilizing air) to 0.2 torr according to the reference torrmeter/transducer. Adjust the VAC CAL potentiometer so that the front panel meter also reads 0.2 torr. Adjust the mechanical adjustment on the front panel meter so that it also reads 2.0 torr. Repeat the process until no further adjustments are necessary.

5.4.3 Vacuum Trigger

To set the VAC level, set the system pressure to 0.2 torr and observe the voltage at pin 7 of J3. J3 is the printed circuit board connector. The voltage will be either zero (0) volts or approximately +125 volts. Set the VAC TRIG adjustment so that this voltage just changes from its zero to its positive level. Allow the system pressure to rise above 0.5 torr (or until the voltage returns to its zero level). Reduce the pressure and verify that the voltage returns to its positive level at 0.2 torr. Reajust VAC TRIG as necessary.

5.4.4 5 Torr Detector

To set the 5 torr level, set the system pressure to 5.0 torr and observe A402 pin 12 of the regulator PC board. The voltage will be either +12VDC or -12VDC. Adjust R414 until the voltage just switches to +12VDC. Reduce the pressure and verify that the voltage switches to -12VDC.

REV.	C
DWG. NO.	C 06513

DIONEX GAS PLASMA SYSTEMS

ENGINEERING PARTS LIST

REV	DESCRIPTION		DATE	CHK	APPR
C	E.O.#11550	A.L	5-82		
B	E. O. #11300	AK	11/81		
A.	E.O. # 10852	AR	3/80		

REVISION LEVEL

DIONEX GAS PLASMA DIVISION

31159 SAN BENITO
HAYWARD, CALIF. 94544

DRAWN A.R.	DATE 3/27/80	TITLE REGULATOR & VACUUM BOARD ASSEMBLY PM 118-119 RF GENERATOR	
CHECKED	DATE 7-15-82		
ENG.	DATE 7-15-82	C	DRAWING NO. 06513 REV. C
		DO NOT SCALE THIS DRAWING	

D03100 D03101 NEXT ASSY.

A05495 REV A

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
C 406	CAPACITOR, CERAMIC DISC .01 μF 500 V.	1500-0001	1
	SPRAGUE 5GAS-510		
C214,C405, C409-411	CAPACITOR, 22 μF, 16 V.	1500-0011	5
	ITT TAG 20/22.0/16-10		
C404,407	CAPACITOR, CERAMIC DISK .1μF 25 V.	1500-0026	2
	CENTRALAB UK20-104		
C205,206 C213 C401,408	CAPACITOR, CERAMIC DISK .001 μF 1000 V	1500-0032	5
	SPRAGUE 5GA-D10		
C201,202 C211,212	CAPACITOR, MICA, 100 pF	1500-0117	4
	ARCO/ELMENCO DM 15- ED 101J03		
C402,403	CAPACITOR, .05 μF 500 V.	1500-0210	2
	SPRAGUE 5HK-550		
C207,208	CAPACITOR, 47 pF 1000 V	1500-0217	2
	SPRAGUE 5GA-Q47		
C203,204 C209,210	CAPACITOR, CERAMIC DISK 10 pF 1000 V	1500-0218	4
	SPRAGUE 5GA-Q10		
C231	CAPACITOR, .1 uF, 50 V.	1500-0249	1
L201,202 L401-404	CHOKE 39 μH	1800-0012	6
	MILLER H9210-56		
1	IC SOCKET 14 PIN	2110-0001	3
W1	JUMPER, GOLD	2120-0401	1
	BERG #65474-101		
4	BERGSTIK, GOLD	2120-0402	1
	BERG #65500-103		
R209,210	RESISTOR, METAL FILM 5.1K 1/4 W.	4602-0053	2

DIONEX
GAS PLASMA DIVISION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: REGULATOR & VACUUM BOARD ASSEMBLY
PM 118-119 RF GENERATOR

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	06513	C		

DRAWN	DATE	SHEET 2 OF
A.R.	3/27/80	

A 04289 REV

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
R 233	RESISTOR, 442K, 1/4 W.	4602-4423	1
R215,216	RESISTOR, CARBON 100Ω 1/4 W.	4702-0101	2
R205,206 R410,413	RESISTOR, CARBON 1K 1/4 W.	4702-0102	4
R211,212 R238, R401,403	RESISTOR, CARBON 10K, 1/4 W.	4702-0103	5
R219	RESISTOR, CARBON, 100K, 1/4 W.	4702-0104	1
R237	RESISTOR, 1M, 1/4 W.	4702-0105	1
R222	RESISTOR, CARBON, 10 MEG 1/4 W.	4702-0106	1
R204	RESISTOR, CARBON, 1.5K, 1/4 W	4702-0152	1
R 402	RESISTOR, CARBON, 22K, 1/4 W.	4702-0223	1
R213,214	RESISTOR, CARBON 220K, 1/4 W.	4702-0224	2
R201,R202 R207,208	RESISTOR, CARBON 27K, 1/4 W.	4702-0273	4
R406,412	RESISTOR, CARBON, 3.3K 1/4 W	4702-0332	2
R404,415	RESISTOR, 390K, 1/4 W	4702-0394	2
R236,240 R405,411,415	RESISTOR, CARBON, 4.7K, 1/4 W	4702-0472	5
R220,221 R234	RESISTOR, CARBON 47K, 1/4 W.	4702-0473	3
R235	RESISTOR, 510K, 1/4 W.	4702-0514	1
R408,409	RESISTOR, CARBON, 680 1/4 W.	4702-0681	2
R203	RESISTOR, CARBON, 6.8K, 1/4 W.	4702-0682	1
R239	RESISTOR, CARBON, 16K, 1/4 W.	4702-0163	1
R218	POTENTIOMETER 50 K	4750-0012	1
	BOURNS 3069P-1-503		
R232	POTENTIOMETER 10 K	4750-0013	1
	BOURNS #3069-1-103		

DIONEX
GAS PLASMA DIVISION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: REGULATOR & VACUUM BOARD ASSEMBLY
PM 118-119 RF GENERATOR

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	06513	C		

DRAWN	DATE	SHEET 3 OF 4
A.R.	3/27/80	

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
R 414	POTENTIOMETER, 1K	4750-0021	1
	BOURNS 3069P-1-102		
R217	POTENTIOMETER, 100K	4750-0022	1
	BOURNS 3069P-1-104		
A201, A401,402	OPERATIONAL AMPLIFIER	4800-0012	3
	FAIRCHILD MA 747		
Q201,202 Q401,402	TRANSISTOR	4800-0024	4
	MOTOROLA 2N 5657		
CR203,204) CR230,241)	DIODE	4800-0045	5
CR 417)	1N4151		
CR201,202	DIODE	4800-0051	2
	ZENER 1N5231		
T401	AUDIO TRANSFORMER	5600-0014	1
	ESSEX TA-45		
2	REGULATOR BOARD BLANK	C 06512	1
3	HEATSINK	B 04485	4
	SCHEMATIC, PM 119	D 03035	REF
	SCHEMATIC, PM 118	D 03034	REF

DIONEX
GAS PLASMA DIVISION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: REGULATOR & VACUUM BOARD ASSEMBLY
PM 118-119 RF GENERATOR

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	06513	C		

DRAWN	DATE	SHEET 4 OF 4
A.R.	3/27/80	

ENGINEERING PARTS LIST 0

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	OSCILLATOR BOARD	C 03039	1
2	FIBER WASHERS		2
	#6 x 1/16" THICK		
3	SOCKET TUBE, 9 PIN	2110-0254	1
	(SAE #5-9388)		
4	CRYSTAL SOCKET	2110-0254	1
	AUGAT 8000 D-61		
C303, 308	CAPACITOR CERAMIC DISK 1 KV .01 μF	1500-0003	2
	SPRAGUE #5GA-S10		
C302, C304 C310	CAPACITOR CERAMIC DISK 1 KV .001 μF	1500-0032	3
	SPRAGUE #5GA-D10		
C309	CAPACITOR MICA 39 pf	1500-0051	1
C301	CAPACITOR CERAMIC DISK 1KV 2200 pf	1500-0212	1
	SPRAGUE #5GA-D22		
C307	CAPACITOR CERAMIC DISK 1KV 47 pf	1500-0217	1
	SPRAGUE #5GA-Q47		
C311	CAPACITOR, DIPPED MICA 500V 200 pf	1500-0223	1
	ARCO/ELMENCO #CM05FD201J03		
C306	CAPACITOR AIR VARIABLE 2-18 pf	1550-0010	1
	E.F. JOHNSON #160-110		
L304	CHOKE 39 mH	1800-0012	1
	MILLER #9210-56		
L302	R.F. CHOKE 100 uH	1800-0253	1
	MILLER #4632		

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: PM 118-119 OSCILLATOR BOARD

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03041	H	DVGH	PGS

DRAWN | DATE 7-13-79 | SHEET 2 OF 3

ENGINEERING PARTS LIST

O

REF. NO.	DESCRIPTION	PART NO.	QTY.
X 301	CRYSTAL 13.56 MHZ	2300-0111	1
E 301-306 E 308, 309	TERMINAL	2860-2008	8
	H.H. SMITH 2008		
R 303	RESISTOR CARBON COMP. 1K ¼W	4702-0102	1
R 301	" " " " " " 100K ¼W	4702-0104	1
R 307	" " " " " " 75K 1W	4704-0753	1
R 310	" " " " " " 1K 2W	4705-0102	1
R 302	" " " " " " 150Ω 2W	4705-0151	1
R 308	" " " " " " 200K 2W	4705-0204	1
R 304-305	" " " " " " 2.2K 2W	4705-0222	2
R 306	" " " " " " 39K 2W	4705-0393	1
R 309	RESISTOR 20K 5W	4706-0203	1
	OHMITE 466J		
CR 301	DIODE	4800-0013	1
	1N4007		
Q 301	TRANSISTOR	4800-0024	1
	2N5657		
L 303	COIL ¼ of IPC #1800-0007	B 03071	1
	AIRDUX 816 A 12 TURNS		
5	HEAT SINK	B-04485	1
	SCHEMATIC	D03035	REF

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: PM 118-119 OSCILLATOR BOARD

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03041	H	DVGH	

DRAWN	DATE	SHEET
	7-13-78	SHEET 3 OF 3

A 03288 REV B

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	HIGH VOLTAGE BOARD	C030751	1
C104	CAPACITOR 100 mfd 350 V DC	1500-0214	1
	SPRAGUE 39D-107F350HS4		
C103	CAPACITOR 20 mfd 450 V DC	1500-0215	1
	SPRAGUE 39D-206F450GL4		
E101-103,	TERMINAL	2860-2008	7
106-108, E111	H.H. SMITH #2008B		
R114-116	RESISTOR CARBON 100K 2W	4705-0104	3
R117-121	" " " " 200K 2W	4707-0204	5
R113	" " " " 1Ω 5W	4706-0010	1
	SPRAGUE #243E1R05		
CR101-126	DIODE	4800-0008	26
	MOTOROLA #MR510		

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: HIGH VOLTAGE BOARD ASS'Y
PM118-119

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03053	B	10-13-78	

DRAWN	DATE	SHEET 2 OF 2
SS.	7-13-78	

A 04289 REV B

ENGINEERING PARTS LIST

O

REF. NO.	DESCRIPTION	PART NO.	QTY.
1	RF COUPLER COVER	B 03257	1
2	RF COUPLER BODY	B 03258	1
3	RF COUPLER CONDUCTOR	B 03259	1
4	NYLON SPACER, .250 THK.	2860-4008	2
	H.H. SMITH #4008		
5	NYLON BHMS	2860-6328	2
	#6-32 x ½"		
C1, C2	CAPACITOR, 1000 MF FEED THRU	1500-0205	2
	ERIE #327-000-X5U0-102M		
J1, J2	UHF CONNECTOR	2180-0190	2
	AMPH #83-798		
R2	RESISTOR, 110 ohm 1 W C.C.	4704-0111	1
R1	POTENTIOMETER	4750-0002	1
	750 ohm A&B TYPE J		
CR1, CR2	DIODE #IN4151	4800-0045	2
6	NYLON #8 WASHER		6
7	#6 SOLDER LUG		2
8	#10 SOLDER LUG		4
9	#318 SOLDER LUG		1
10	#12 GA BUSS WIRE		A/R
11	#18 GA BUSS WIRE		A/R

INTERNATIONAL PLASMA CORPORATION
31159 SAN BENITO
HAYWARD, CALIF.
94544

TITLE: R F COUPLER ASS'Y

SIZE	DWG. NO.	REV.	CHK.	APPR.
C	03260	D	A. Rocha 8-4-78	

DRAWN	DATE	SHEET
	7-12-78	SHEET 2 OF 2

DIONEX GAS PLASMA SYSTEMS

ENGINEERING PARTS LIST

DWG. NO.	REV.
D 03100	S

REV	DESCRIPTION			DATE	CHK	APPR
S	REVISED E.O. #11803	5/4/83	KG	5/2/83		D.H
R	REVISED E.O. #11719	4/30/83	KG	5/3/83		D.H
P	REVISED E.O. #11662		SO	10-82		D.H
N	E.O. #11206 & #11259		AK	10-81		
M	E.O.#11153		AS	7-27-81		
L	EO#10935, 10942, 10916		M.S.	12-4-80	1-15-81	
K	E.O. 10852			9/80		PGD
J	E.O. #10655, 10870		MS	4-1-80		
I	E.O. 10705		PB	3/80		

REVISION LEVEL

DIONEX GAS PLASMA DIVISION

31158 SAN BENITO
HAYWARD, CALIF. 94544

DRAWN	DATE	TITLE	
CHECKED	DATE	PM 119 R. F. GENERATOR TOP ASSEMBLY	
ENG.	DATE	DRAWING NO. 0310Q	REV. S
		DO NOT SCALE THIS DRAWING	

NEXT ASSY. 03100

A05495 REV A

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
T1	POWER TRANSFORMER	C 02933	1
1	TOP COVER REAR	C 02940	1
28	REAR PANEL	C 02942	1
2	POWER TUBE SUPPORT BRACKET	C 02943	1
3	RF TUNING BAFFLE & FAN SUPPORT BRACKET	D 02944	1
4	WINDOW BRACKET	C 02945	1
5	TEFLON INSULATOR GENERATOR	B 02946	1
6	SIDE COVER, RIGHT	C 02948	1
7	MAIN CHASSIS	D 02949	1
8	CHASSIS FRONT PANEL	C 02950	1
9	RFI SHIELD	C 02951	1
10	COIL SUPPORT BAR (FIXED)	C 02952	1
11	COIL SUPPORT BAR (LOWER)	B 02953	1
12	ADJ POT MOUNTING BRACKET	B 02954	1
13	REGULATOR BD MOUNTING BRACKET	B 02955	1
14	BOTTOM COVER	C 02956	1
15	RF GENERATOR SCREEN BRACKET	B 02959	2
29	FRONT PANEL DECAL	C 02960	1
REF	SCHEMATIC	D 03035	1
A3	OSCILLATOR BD ASSEMBLY	C 03041	1
A1	HIGH VOLTAGE BD ASSEMBLY	C 03053	1
31	REAR PANEL SCREENS	B 03056	2
16	RF GENERATOR SKIDS	B 03057	3
17	BEZEL BAR	B 03058	2
REF	HARNESS	C 03059	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
PM 119 RF GENERATOR
TOP ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	03100	S		

DRAWN	DATE	SHEET
JV	8-18-78	SHEET 3 OF 7

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
L3	INDUCTOR, AIR VARIABLE	C 03063	1
19	FLEXIBLE RF STRAP	B 03077	1
20	NEUTRALIZING CAPACITOR BRACKET	B 03078	1
21	FRONT PANEL BRACKET LEFT	B 03081	1
25	PLATE CAPACITOR BRACKET	B 03082	1
22	RF OUTPUT PLATE	B 03083	1
23	SAFETY SHIELD AC POWER STRIP	B 03084	1
24	OUTPUT COIL ADJUSTMENT SCREW	B 03085	1
26	OUTPUT COIL TIE STRAP	B 03111	1
REF	INSTRUCTION MANUAL	A 03144	1
A4	RF COUPLER ASSEMBLY	C 03260	1
27	POWER SWITCH SUPPORT BRACKET	B 03325	1
59	REGULATOR BD SUPPORT BRACKET	B 03374	1
32	NEUTRALIZING CAPACITOR: STRAP	B 04302	1
36	LOWER COIL SUPPORT SPACER	B 04535	1
34	TOP COVER FRONT	C 04604	1
30	BEZEL DECAL	C 04606	1
35	LEFT SIDE COVER	D 04607	1
33	FRONT PANEL BRACKET RIGHT SIDE	B 04608	1
58	L3 TO OUTPUT PLATE STRAP	B 04610	1
A2	REGULATOR BD ASSEMBLY	C 06513	1
18	HIGH VOLTAGE BD. MOUNTING BRACKET	B 03076	4

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
PM 119 RF GENERATOR
TOP ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	03100	S		

DRAWN	DATE	SHEET
JV	8-18-78	4 OF 7

ENGINEERING PARTS LIST

REF. NO.	DESCRIPTION	PART NO.	QTY.
C20, 21	CERAMIC DISC .01 μF 500V SPRAGUE 5GAS-S10	1500-0001	2
C1, 2	CAPACITOR 480 μF 450V MALLORY CGS 481-450 DFI	1500-0037	2
C22, 14-16	CAPACITOR 1000pF 500V ARCO/ELMENCO DM 1gFD102 13	1500-0116	4
C5	CAPACITOR 4 μF 3000V ARCO/ELMENCO DM 15-ED101 J03	1500-0177	1
C9,10,11,18,19	CERAMIC TUBULAR CAPACITOR CENTRALAB 8505-100N	1500-0189	5
C6, 7, 13	CERAMIC TUBULAR CAPACITOR, 1000pF 5KV	1500-0191	3
	CENTRAL 85-5-50Z		
C8, 23	CERAMIC TUBULAR CAPACITOR 50pF 7.5KV	1500-0192	2
	CENTRAL 8585-1000		
57	CAPACITOR MT'G RINGS 2" ID	1525-0002	2
C12	AIR VARIABLE CAPACITOR, EF JOHNSON 154-0003-001	1550-0247	1
L1, 5	CHOKE RF 10μH MILLER 4612	1800-0006	2
L2	COIL AIR DUX 1212A	1800-0100	1
L4	CHOKE RF 100μH MILLER 4632	1800-0253	1
J3	EDGE CONNECTOR VECTOR R6rr P.C. SOCKET	2100-0223	1
37	8 PIN SOCKET CINCH 8AM	2110-0170	1
38	POWER TUBE SOCKET EIMAC SK800B	2110-0200	1
61	TUBE CHIMNEY EIMAC SK-806	2110-0201	1
39	QUICK DISCONNECT,FEMALE HOLINGSWORTH SO-5075	2120-5075	3
40	QUICK DISCONNECT MALE HOLLINGSWORTH SO-5076	2120-5076	3
J1	9 PIN (F) PANEL CONNECTOR AMPH. MS 3102 A-22-195	2152-2216	1
J2	4 PIN (M) PANEL CONNECTOR AMPH. MS 3102 A-145-25	2152-2417	1

BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
PM 119 RF GENERATOR
TOP ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	03100	S		

DRAWN	DATE	SHEET
JV	8-18-89	SHEET 5 OF 7

ENGINEERING PARTS LIST

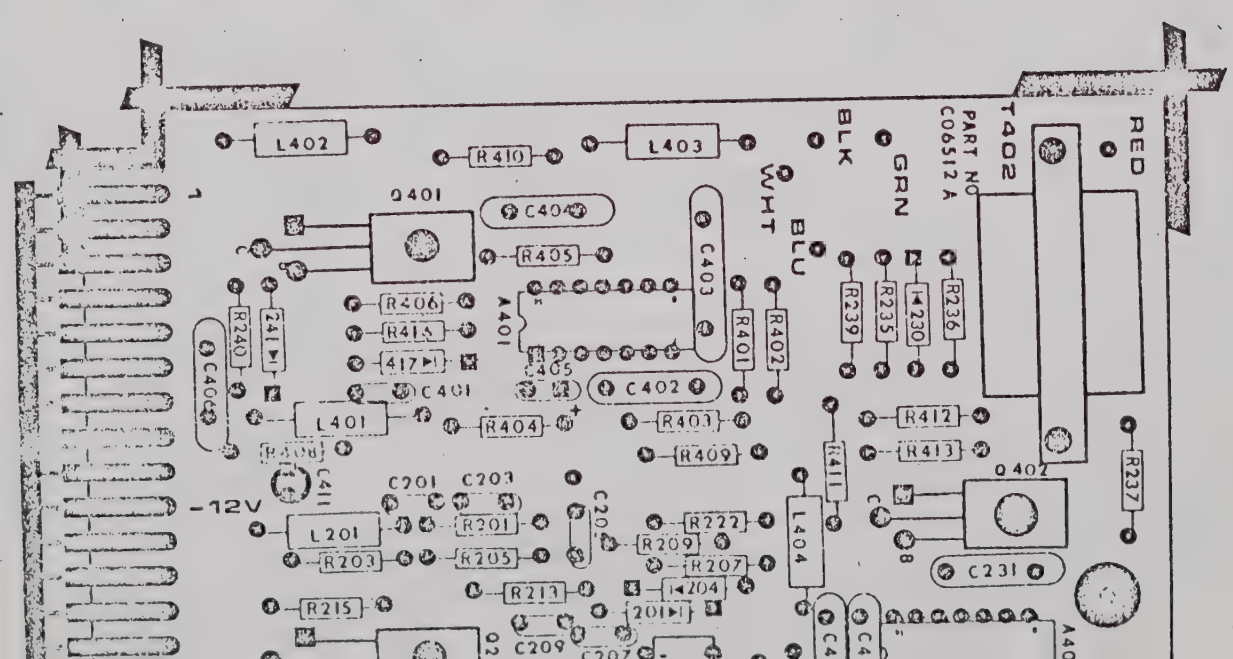
REF. NO.	DESCRIPTION	PART NO.	QTY.
41	INSULATED STANDOFF USECO 1417-9	2160-0207	5
TB1	BARRIER STRIP CINCH 10-142	2170-0193	1
42	MARKER STRIP CINCH MS 10-142	2170-0222	1
43	CONNECTOR UHF F-F AMPH 29500	2180-0002	2
44	CONNECTOR DBL MALE UHF DOWKEY F3-125	2180-0024	2 (H)
45	CONNECTOR UHF BULKHEAD AMPH 83-798	2180-0190	1
46	CONNECTOR ELBOW 90° AMPH 83-1AP	2180-0218	1
47	PWR CABLE CLAMP ELECTROLINE L51-2 SCREW CLAMP	2190-0001	1
B1	FAN, COOLING 148VK-282	2600-0190	1
48	FURNITURE LEVELER FRANKIN SILENT GLIDE 6242	2800-0005	6
TB2	TERMINAL STRIP CINCH JONES 54C	2860-0866	1
60	SHOULDER FIBER WASHER	2860-2154	4
D51,2	LAMP AMBER 115V DIALCO 507-4537-1433	3900-0001	2
52	LAMP SOCKET DIALCO 515-0074	3900-0005	2
50	LAMP CLIP DIALCO 515-0051 SPEED CLIP	3900-0006	2
51	LAMP WASHER ELDEMA Q145-008	3900-0007	2
K1	TIME DELAY RELAY 120V POTTER BRUMFIELD CHB 38-7003	4500-0159	1

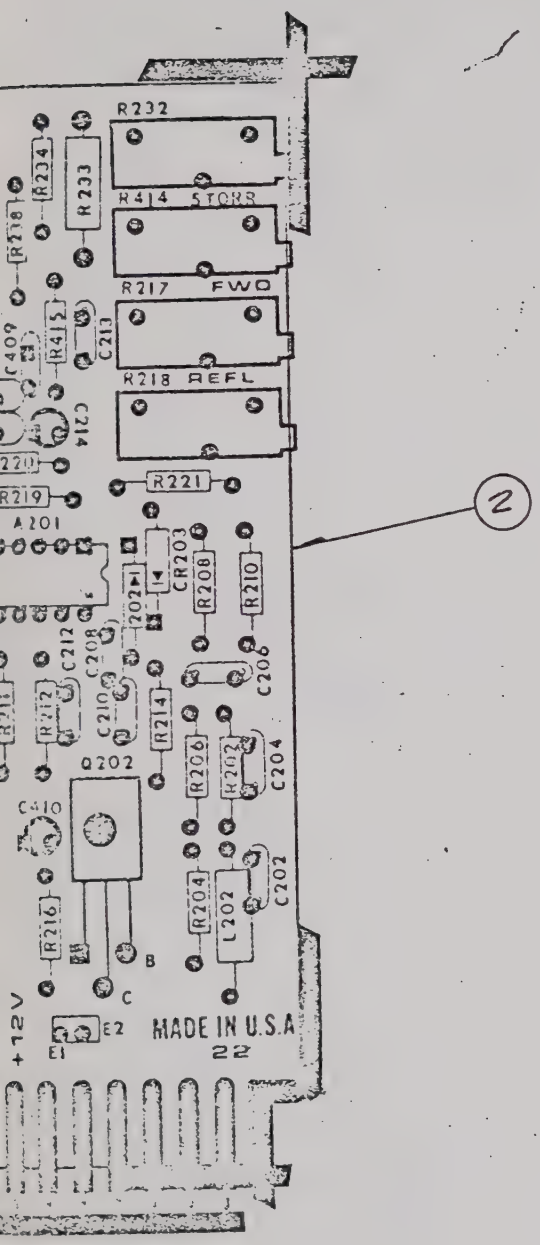
BRANSON/IPC
a SmithKline company
31172 HUNTWOOD AVE
HAYWARD, CALIFORNIA
94544

TITLE
PM 119 RF GENERATOR
TOP ASSEMBLY

SIZE	DWG. NO.	REV.	CHK.	APPR.
D	03100	S		

DRAWN	DATE	SHEET
JV	8-18-78	SHEET 6 OF 7


L402
R410
L403
Q401
C404
R405
C403
R406
R415
R417
C405
C401
R401
R402
A401
R240
R241
C406
L401
R404
C402
R403
R409
C411
C201
C203
-12V
L201
R201
R203
R205
C209
R213
R215
R222
R209
R207
R204
L404
R411
R412
R413
Q402
C231
R237
T402
PART NO
C06512 A
BLK
GRN
WHT
BLU
RED
R239
R235
R230
R236



(2)

REV	DESCRIPTION	DATE	CHK	APPR
C	EO # 11550	12-82	CJ	
B	EO # 11300	11-81		
A	E.O. # 10852	3-80		

REVISION LEVEL

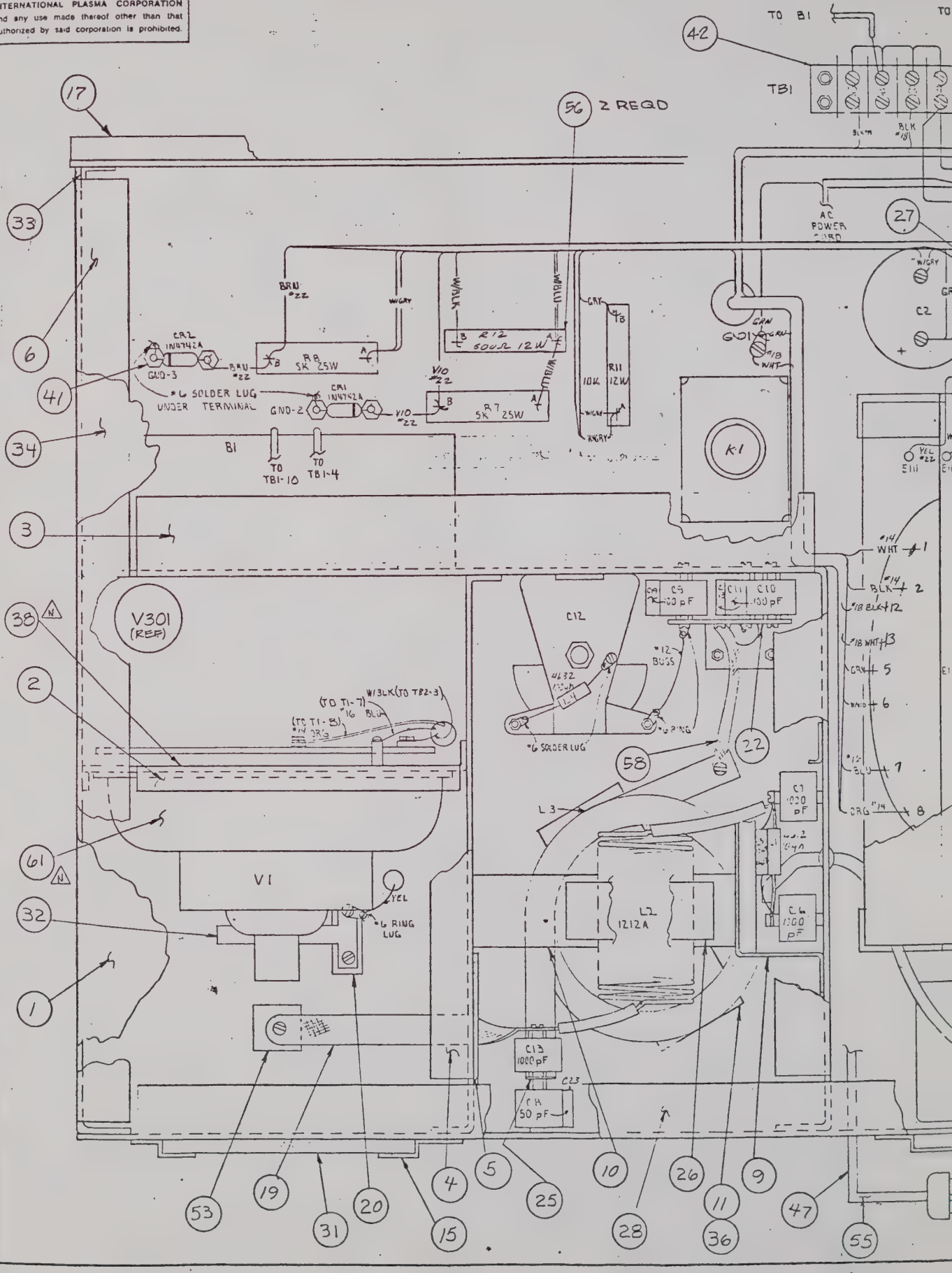
DIONEX GAS PLASMA DIVISION

1228 SAN PEDRO
HAYWARD, CALIF. 94545

DRAWN	DATE	TITLE: ASSEMBLY DRAWING REGULATOR, VACUUM BOARD PM 118,119 GENERATOR
CHECKED	DATE	
ENG	DATE	SIZE: C — DRAWING NO: 06513 — REV: C
SCALE 2:1	DO NOT SCALE THIS DRAWING	SHEET 1 OF 4

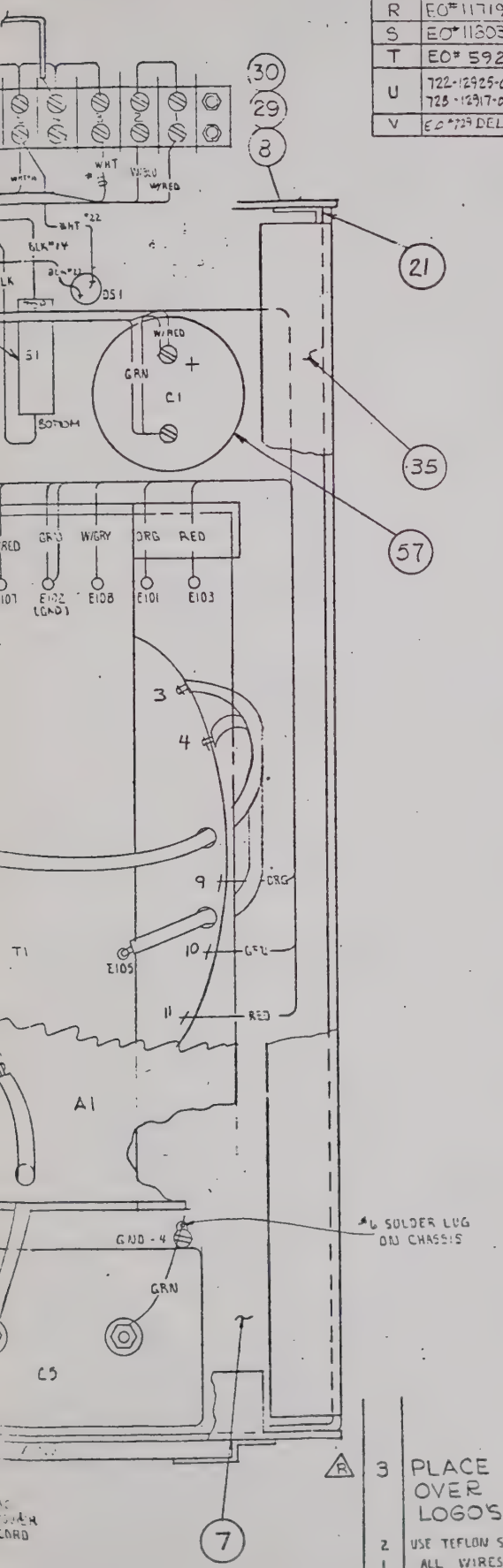
NEXT ASSY

This document is the confidential property of INTERNATIONAL PLASMA CORPORATION and any use made thereof other than that authorized by said corporation is prohibited.



REV	DESCRIPTION	CK	DATE	APPR
R	EO# 11719			
S	EO# 11803			
T	EO# 592			
U	722-12925-01 AND 723-12917-01 ADDED	EO 637 / 634		
V	EO# 739 DELETE ITEM 18			

REV	DESCRIPTION	PREP	DATE	APPR
B	REVISED	JV	6-17-76	
C	EO #10203, 10204, 10206	JV	8-30-76	
D	ADD C19 & CORRECT WIRING	JV	9-30-76	
E	[illegible]	JV	2-15-77	
F	EO# 10241	JV	3-3-78	
G	EO# 10245	JV	5-22-78	
H	EO 10512	KG	3-28-79	
I	E.O. # 10852	AR	3-17-80	
L	E.O. # 10916	M.S.	11-25-80	
M	E.O. #11153	AS	7-27-81	
N	EO # 11206 & 11259	AK	11-2-81	
P	EO # 11662	SD	4-27-83	



WIRE LIST

COLOR	START	BREAK OUT AT	END	NOTES
BLK	AC POWER CORD		S1 - BOTTOM	BELDON 6000 - 0020
WHT			TB1-6	
GRN	AC POWER CORD		GND-1	BELDON 6000-0020
BLK #14	TB1-10		T1-2	
WHT #14	TB1-9		T1-1	
BLK #14	S1-TOP		TB1-7	
BLK #22	DS1		TB1-7	
WHT #22	DS1		TB1-5	
#18 BLK	TB1-8		K1-7	
#18 WHT	TB1-3		K1-2	
FAN	B1		TB1-4	NOT IN HARNESS
FAN	B1		TB1-9	NOT IN HARNESS
BLK #18	T1-12		J1-B	
WHT #18	T1-13		GND	
GRN	J1-L		GND-7	
GRN	T1-5		GND-1	
W/V10	T1-6		E308	
BLU #16	T1-7		V1-GND	
ORG #14	T1-8		V1-FIL	SLIP ON CONNECTOR IPC =
	T1-3		E104	BELDON 8998
	T1-4		E105	BELDON 8898
ORG	T1-9		E101	
GRN	T1-10	E102, C1(-), C2(+)	GND-1	
RED	T1-11		E103	
	C5		E110	BELDON 8898
	C5		C6	BELDON 8898
GRN	C5		GND-4	NOT IN HARNESS
W/GRY	E108	C2(-), R11-A, R8-A	R6	
W/RED	E107	C1(+), TB1-1	E302	
W/BLK	T2-8	T82-3	V1-SCREEN	
V10 #22	C5	R7-B, K1-8	J3-16, T	
BRN #22	R5-B	J3-10, L	J1-K	
GRY	R11-B		E305	
	C7		L2	BELDON 8898
	C3		L2	BELDON 8898
BRN	R5-B		CR2	JUMPER
YEL #22	E111		T72-2	
W/BLU	TB2-2	R12-A	TB2-4	
W/BLU	R12-A		R7-A	JUMPER

D 03100

3	PLACE ITEM 62 & 63 OVER EXISTING LOGO'S	
2	USE TEFLON SLEEVING ON ALL JUMPER ALL WIRES ARE 18 GA UNLESS OTHERWISE SPECIFIED	
1		

FIND NO.	NOTES
PREP	
CHECK	12/20/76
APPR	12/31/76
MATERIAL	
FINISH	

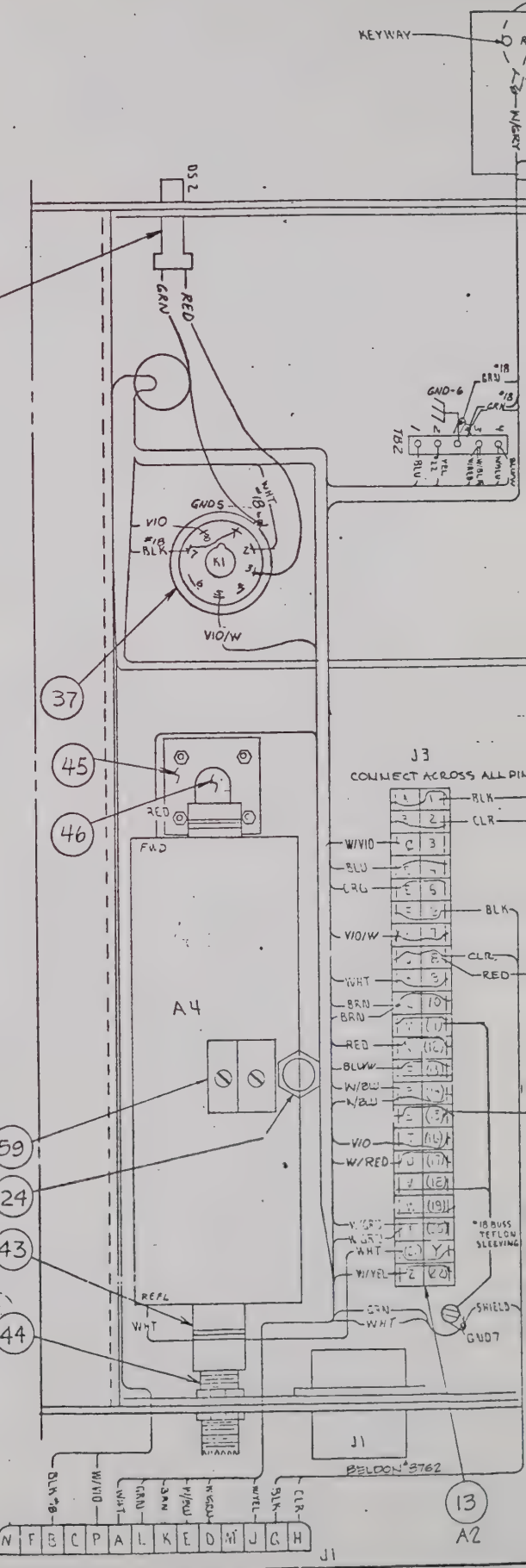
INTERNATIONAL PLASMA CORP.
HAYWARD, CALIFORNIA

TITLE
PM 119
TOP ASS'Y AND WIRE LISTS

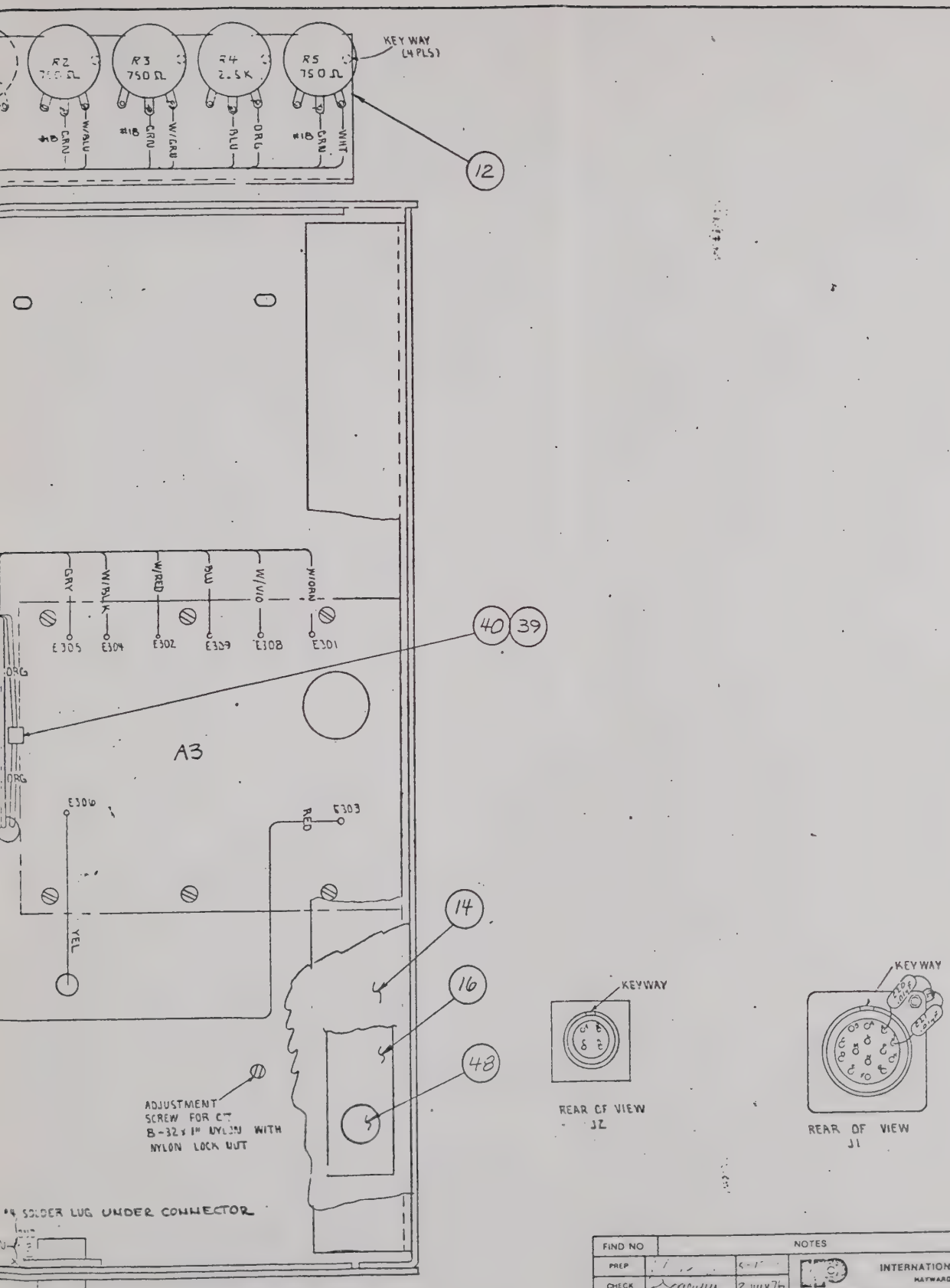
SIZE D | DRAWING NO. 03100 | SCALE | SHEET 1 OF 7

This document is the confidential property of INTERNATIONAL PLASMA CORPORATION and any use made thereof other than that authorized by said corporation is prohibited.

WIRE LIST				
COLOR	START	BREAK OUT AT	END	NOTES
BLU	J3-4, D		R4	
ORG	R4		J3-5, E	
WHT	J3-9, K		R5	
GRN #18	R3		GND-6	
RED	J3-12, N		A4-FWD	
W/BLU	R2	J3-14, R	J1-E	
RED	J3-19, W	JUMPER TO J3-15, S	E303	
W/GRN	R3	J3-20, X	J1-D	
WHT	J3-21, Y		A4-REFL	
W/YEL	J3-22, Z		J1-J	
CLR	J3-8, J		J1-H	BELDON 8762
BLK	J3-1, F		J1-G	↕
SHIELD	GND-7			BELDON 8762
RED	J3-8, J		J2-A	BELDON 8770
BLK	J3-1, A		J2-B	↕
CLR	J3-2, B		J2-C	
GRN	J2-D		GND-5	BELDON 8770
YEL	E304		C17	NOT IN HARNESS
RED	DS2		K1-3	↓ ↓
GRN	DS2		GND-5	NOT IN HARNESS
BLU	E303		TB2-1	
W/BLK	R6		E304	
W/RED	TB2-3		J3-17	
GRN #18	R2		GND-6	
GRN #18	R5		GND-6	
W/VIO	J3-3		J1-P	
WHT	J1-A		GND-7	
	TB1-1		TB1-2	
	TB1-3		TB1-4	
	TB1-4		TB1-5	JUMPER
	TB1-5		TB1-6	
	TB1-7		TB1-8	
	TB1-8		TB1-9	
	TB1-9		TB1-10	
#18 GLASS TEFLON SLEEVING	GND 7		J3-11	
BLK	K1-7		K1-1	
VIO/W	K1-5		J3-7	
BLU/W	TB2-4		J3-13	

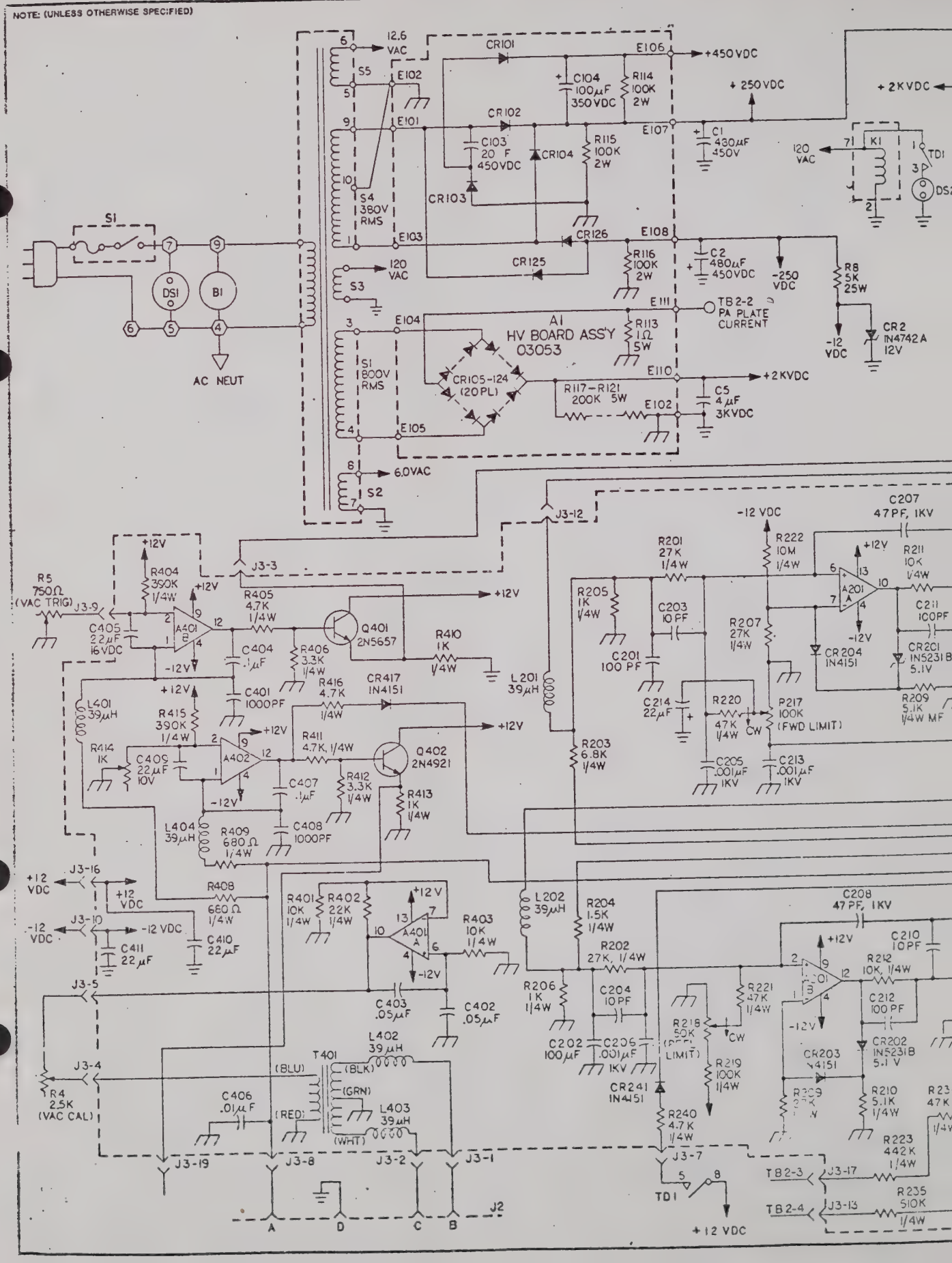


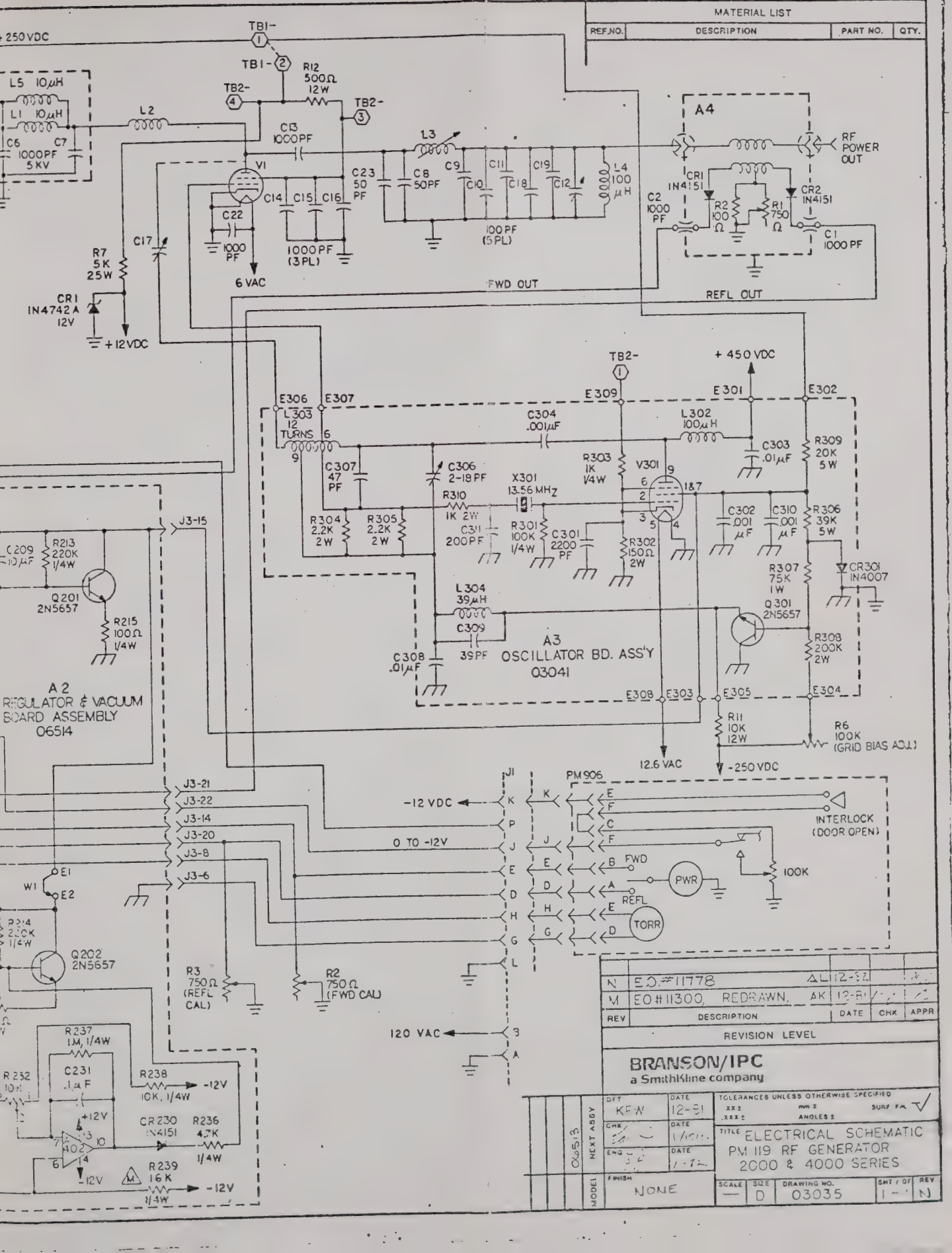
3 INSULATED SLIP ON CONNECTOR IPC # 2120-5075 & 2120-5076
2 MOUNT BACK PANEL PLUGS WITH KEYWAYS IN UP POSITION WHEN MACHINE IS IN OPERATING POSITION
1 ALL WIRES FROM J3 22 GA, UNLESS OTHERWISE SPECIFIED



FIND NO	NOTES		
PREP			INTERNATIONAL PLASMA CORP. HAYWARD, CALIFORNIA
CHECK		2 JULY 76	
APPR		6/30/76	TITLE: PM 119 TOP ASS'Y AND WIRE LISTS
MATERIAL			SIZE D · DRAWING NO 03100 · Y
FINISH			SCALE · SHEET 2 OF 7

D 03100 Y


NOTE: (UNLESS OTHERWISE SPECIFIED)
12.6 VAC
S5
E102
E101
S4 380V RMS
E103
120 VAC
S3
S1 800V RMS
E104
E105
6.0VAC
S2
CR101
E106
+450VDC
C104 100µF 350VDC
R114 100K 2W
+250VDC
+2KVDC
CR102
E107
C103 20 F 450VDC
CR104
R115 100K 2W
CR103
C1 430µF 450V
120 VAC
K1
TD1
DS2
CR126
E108
CR125
R116 100K 2W
C2 480µF 450VDC
-250 VDC
R8 5K 25W
E111
TB2-2 PA PLATE CURRENT
A1 HV BOARD ASS'Y 03053
R113 1Ω 5W
CR105-124 (20PL)
R117-R121 200K 5W
E110
+2KVDC
C5 4 µF 3KVDC
-12 VDC
CR2 IN4742A 12V
S1
DS1
B1
AC NEUT
J3-12
-12 VDC
C207 47PF, 1KV
+12V
J3-3
R5 750Ω (VAC TRIG)
J3-9
R404 390K 1/4W
R405 4.7K 1/4W
Q401 2N5657
R410 1K 1/4W
C405 22µF 16VDC
A401
C404 .1µF
R406 3.3K 1/4W
C401 1000PF
R416 4.7K 1/4W
CR417 IN4151
L401 39µH
R415 390K 1/4W
R414 1K
C409 22µF 10V
A402
R411 4.7K, 1/4W
Q402 2N4921
C407 .1µF
R412 3.3K 1/4W
R413 1K 1/4W
L404 39µH
R409 680Ω 1/4W
C408 1000PF
L201 39µH
R203 6.8K 1/4W
R201 27K 1/4W
R205 1K 1/4W
C203 10 PF
C201 100 PF
C214 22µF
R222 10M 1/4W
R207 27K 1/4W
R220 47K 1/4W CW
P217 100K (FWD LIMIT)
C205 .001µF 1KV
C213 .001µF 1KV
A201
R211 10K 1/4W
C211 100PF
CR204 IN4151
CR201 IN5231B 5.1V
R209 5.1K 1/4W MF
J3-16
+12 VDC
J3-10
-12 VDC
R408 680Ω 1/4W
C411 22µF
C410 22µF
J3-5
J3-4
R4 2.5K (VAC CAL)
C406 .01µF
T401
(BLU)
(BLK)
(GRN)
(RED)
(WHT)
L402 39µH
L403 39µH
R401 10K 1/4W
R402 22K 1/4W
A401
R403 10K 1/4W
C403 .05µF
C402 .05µF
L202 39µH
R204 1.5K 1/4W
R202 27K, 1/4W
R206 1K 1/4W
C204 10PF
C202 100µF
C206 .001µF 1KV
R218 50K (PEAK LIMIT) CW
R219 100K 1/4W
CR241 IN4151
R240 4.7K 1/4W
C208 47 PF, 1KV
C210 10PF
R212 10K, 1/4W
C212 100 PF
A201
CR203 IN4151
CR202 IN5231B 5.1 V
R210 5.1K 1/4W
R221 47K 1/4W
R223 442K 1/4W
R235 510K 1/4W
J3-19
J3-8
J3-2
J3-1
J3-7
J3-17
J3-13
TB2-3
TB2-4
TD1
+12 VDC
J2
A
D
C
B


MATERIAL LIST
REF.NO. DESCRIPTION PART NO. QTY.
+250VDC
TB1-
TB2-
L5 10μH
L1 10μH
L2
C6 1000PF 5KV
C7
R12 500Ω 12W
C13 1000PF
L3
V1
C14 C15 C16
C22 1000 PF
1000PF (3PL)
C23 50 PF
C8 50PF
C9 C10 C11 C18 C19 C12
100PF (5PL)
L4 100 μH
A4
RF POWER OUT
CR1 IN4151
CR2 IN4151
R2 100 Ω
R1 750 Ω
C2 1000 PF
C1 1000 PF
REFL OUT
FWD OUT
C17
R7 5K 25W
CR1 IN4742A 12V
+12VDC
6 VAC
+450 VDC
E306 E307 E309 E301 E302
L303 12 TURNS
C304 .001μF
L302 100μH
C303 .01μF
R309 20K 5W
C307 47 PF
C306 2-18PF
X301 13.56 MHz
R303 1K 1/4W
V301
R310 1K 2W
C311 200PF
R304 2.2K 2W
R305 2.2K 2W
R301 100K 1/4W
C301 2200 PF
R302 150Ω 2W
C302 .001 μF
C310 .001 μF
R306 39K 5W
R307 75K 1W
CR301 IN4007
L304 39μH
C309 39PF
C308 .01μF
A3 OSCILLATOR BD. ASS'Y 03041
Q301 2N5657
R308 200K 2W
E308 E303 E305 E304
R11 10K 12W
R6 100K (GRID BIAS ADJ.)
12.6 VAC
-250 VDC
J3-15
C209 10μF
R213 220K 1/4W
Q201 2N5657
R215 100Ω 1/4W
A2 REGULATOR & VACUUM BOARD ASSEMBLY 06514
J3-21
J3-22
J3-14
J3-20
J3-8
J3-6
J1
-12 VDC
0 TO -12V
120 VAC
PM906
INTERLOCK (DOOR OPEN)
100K
PWR
FWD
REFL
TORR
W1 E1 E2
R214 220K 1/4W
Q202 2N5657
R3 750Ω (REFL CAL)
R2 750Ω (FWD CAL)
R237 1M, 1/4W
C231 .1μF
R238 10K, 1/4W
R232 10K
+12V
-12V
CR230 IN4151
R236 4.7K 1/4W
R239 16K 1/4W
402
N E.O.#11778 AL 12-31
M E.O.#11300, REDRAWN, AK 12-81
REV DESCRIPTION DATE CHK APPR
REVISION LEVEL
BRANSON/IPC
a SmithKline company
DFT KFW 12-81
CHK DATE
ENG DATE
TOLERANCES UNLESS OTHERWISE SPECIFIED
XX± mm ± SURF FIN
.XXX± ANGLES ±
TITLE ELECTRICAL SCHEMATIC PM 119 RF GENERATOR 2000 & 4000 SERIES
MODEL 06513 NEXT ASSY
FINISH NONE
SCALE — SIZE D DRAWING NO. 03035 SHT 1 OF 1 REV N

S-2000
Etcher/Stripper

BRANSON/IPC

BRANSON INTERNATIONAL PLASMA CORPORATION

- **Fast**—Etch rates of SiN_4 greater than 500 Å/min. Throughput of 50 wafers per load.
- **Automatic**—A single button initiates routine processing.
- **Programmable**—Gas flow, chamber pressure, RF power and etch and/or strip time can be selected.
- **Flexible**—Handles 3-inch, 4-inch (100 mm) and 5-inch (125 mm) silicon devices coated with Polysilicon, Silicon Nitride or photoresist.
- **Clean**—Quartz chamber minimizes the need for cleaning.
- **Easy-to-Maintain**—Rugged construction minimizes need for servicing.

Specifications

Process Type
Three plasma processes for batch etching and/or stripping of Silicon wafers, hybrid circuits and other microelectronic devices.

Materials
- Material Type:
  Silicon wafers coated with Polysilicon
  Silicon wafers coated with Silicon Nitride
  Silicon wafers coated with photoresist
- Substrate Diameter:

Chamber Size	Diameter
8 in.	3 in.
10 in.	3 in., 4 in. (100 mm)
12 in.	3 in., 4 in. (100 mm), 5 in. (125 mm)

- Substrate Thickness: any thickness

RF Power
- Branson/IPC variable-output generator
- Generator is air-cooled, shielded to meet radio frequency interference (RFI) and Federal Communication Commission (FCC) requirements, and RF power output is electronically stabilized
- Automatic impedance-matching network (AutoMatch®)
- Generator Sizes:

System Size	Power
8 in.	500 Watt or 750 Watt
10 in.	500 Watt or 750 Watt
12 in.	1000 Watt

Throughput
Throughput depends on process type and substrate thickness. All three sizes of system have a 50-wafer capacity.

Operating Modes
Automatic Mode for routine wafer processing. Manual Mode allows override of process controls for determining and entering process parameters and for performing diagnostics.

Adjustable Process Parameters
- Gas flow for each of the three process programs.
- RF power for each of the three process programs
- First process termination via time or, optionally, temperature control
- Second and third process termination via time or, optionally, end-of-process characteristic detection

Controls
- Thumbwheel switch for dialing in process time (up to 99.9 minutes)
- A/C power switch
- Vacuum toggle switch
- Purge gas toggle switch
- System operating mode (manual or automatic) toggle switch
- 3 gas flow toggle switches, one for each process
- 3 gas flow rate knobs, one for each process
- 3 RF power toggle switches, one for each process
- 3 RF power level knobs, one for each process
- Forward or reflected RF power selection switch
- Start pushbutton
- Cycle pushbutton
- Reset pushbutton
- Time/bypass/temp switch for the first process program
- 2 time/bypass/detector switches, one for the second process program and one for the third process program. Customer specifies which program (second or third) is to be terminated by end-of-process characteristic detection.

Temperature Control
- Chamber temperature can be set up to 199° C; typical chamber process temperature is 80° C to 120° C
- Optional temperature programmer with digital readout and selectable pre-heating up to 199° C allows selection of temperature at which etching begins

End-of-Process Detection (optional)
- emission sensor detects plasma spectrum change
- strip chart recorder prints end-of-process plot

Chamber
- Fused quartz chamber
- Six gas inlets for even distribution of process gas
- Five exhaust outlets for cross-laminar flow
- The chamber is surrounded by a cylindrical, perforated metal etch tunnel which shields the wafers from radiation damage

Data Display
- Digital process time display (up to 99.9 minutes)
- Analog forward and reflected RF power level meters
- Analog chamber pressure meter (0 to 20 Torr)
- Digital temperature readout (up to 300° C)
- 3 glass tube flow indicators, one for each process
- Audible alarm and red indicator light report process completion
- Optional capacitance manometer with digital chamber pressure display

Safety Features
- RF power automatically turns off whenever the reactor center cover is removed
- Pressure interlock prevents system from turning on when pressure is above 5 Torr

Maintenance Features
- Rugged construction minimizes the need for servicing
- All components are easily accessible

Fittings
- All gas inlets accommodate 1/4-inch (outer diameter) tubing

Exhaust System
- Exhaust pipe 1 3/4-inch (outer diameter)
- 6-foot flexible Tygon vacuum hose with rigid spiral steel insert (1 3/4-inch, inner diameter)

Vacuum Pumps
- 17 cfm for the 8-inch system
- 23 cfm for the 10-inch system
- 35 cfm for the 12-inch system

Dimensions and Weight
- 8-inch system reactor center:
  24 in. (61 cm) wide
  18 in. (46 cm) high
  33 in. (84 cm) deep
  weight: 100 lbs. (45 kg)
- 10-inch or 12-inch system reactor center:
  28 in. (71 cm) wide
  20 in. (51 cm) high
  32 in. (81 cm) deep
  weight: 110 lbs. (50 kg)
- Controller:
  25 in. (63 cm) wide
  9 in. (23 cm) high
  19 in. (4 cm) deep
  weight: 45 lbs. (20 kg)

- RF power generators:
  500-Watt:
  16 1/4 in. (41.3 cm) wide
  11 7/8 in. (30.2 cm) high
  21 1/4 in. (54 cm) deep
  weight: 105 lbs. (48 kg)

  750 or 1000-Watt:
  20 in. (50.8 cm) wide
  14 in. (35.6 cm) high
  25 in. (63.5 cm) deep
  weight: 160 lbs. (73 kg)

Power Requirements

- System with 500-Watt RF power generator:
  117 Volts AC, 50/60 Hz, single-phase, 15 Amps
- System with 750 or 1000-Watt power generator:
  208/240 Volts AC, 50/60 Hz, single-phase, 31 Amps
- Pumps—power requirements will vary with pump brand and local standards; those recommended by Branson/IPC have the following requirements:
  17 cfm—115/230 Volts, 60 Hz, single-phase, 1 HP
  220/380 Volts, 50 Hz, three-phase, 1 HP
  23 cfm—115/230 Volts, 60 Hz, single-phase, 1 1/2 HP
  220/380 Volts, 50 Hz, three-phase, 1 1/2 HP
  35 cfm—115/230 Volts, 60 Hz, single-phase
  220/380 Volts, 50 Hz, three-phase

Other voltages available upon request.

User-Supplied Equipment includes:

- Process gas supplies, regulators, controls, indicators, manifolds, cabinet and connections.
- Purge gas supplies, regulators, controls, indicators, manifolds and connections.
- Air or nitrogen pneumatic actuation supply at 60 to 75 psig via 1/4" tube.

Ordering Information

S-2000 Etcher/Stripper, 8-inch diameter with:

	Order Number
500-Watt RF generator	S2005-1820
500-Watt RF generator and temperature programmer	S2005T-1820
750-Watt RF generator	S2075-1820
750-Watt RF generator and temperature programmer	S2075T-1820

S-2000 Etcher/Stripper, 10-inch diameter with:

500-Watt RF generator	S2005-11020
500-Watt RF generator and temperature programmer	S2005T-11020
750-Watt RF generator	S2075-11020
750-Watt RF generator and temperature programmer	S2075T-11020

S-2000 Etcher/Stripper, 12-inch diameter with:

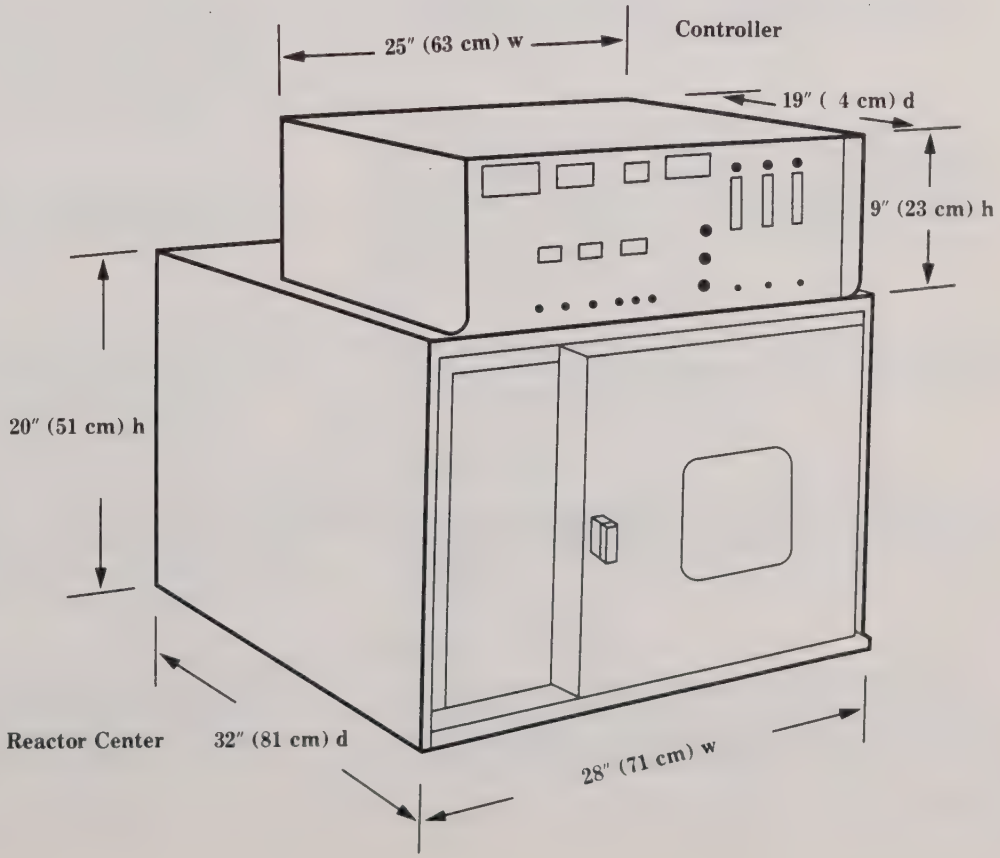
1000-Watt RF generator	S2100-11220
1000-Watt RF generator and temperature programmer	S2100T-11220

Options (specify when ordering)

End-of-etch emission detector (specify if for Polysilicon, Silicon Nitride or photoresist and whether detector is to be used for the second or third process program)	DPS 2300
Tygon soft plumbing instead of stainless-steel tubing in the gas controller	A10461
Capacitance manometer with digital chamber pressure display (only on the hard-plumbed system)	PM 410
Two mass flow controllers, one up to 300 sccm and one up to 100 sccm for the second or third process program (only on the system with capacitance manometer and hard plumbing)	A 10462

Accessories

Quartz Lattice Tray for:	
8-inch system	P/N 05772
10-inch system	P/N 05887
12-inch system	P/N 05367
Quartz Dump Transfer Cassette for 3-inch wafers for:	
8-inch system	P/N 04927
10-inch system	P/N 03144
Quartz Dump Transfer Cassette for 100 mm wafers for:	
10-inch system	P/N 04923
12-inch system	P/N 05750
Quartz Dump Transfer Cassette for 125 mm wafers:	P/N 07737
Aluminum Backing Plates for:	
3-inch wafers (25 per set)	04720
100 mm wafers (25 per set)	02624-006



BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

Fundamentals of Plasma-Etching

Plasmas are used extensively for etching metals, semiconductors and dielectrics during the processing of microelectronic wafers. Economical commercial processes have been developed for etching materials such as silicon, silicon dioxide, silicon nitride, aluminum, tantalum, tantalum compounds, chromium, tungsten, gold and glass.

This bulletin is an introduction to the plasma-etching of wafers. It gives basic information about the nature of plasmas, the features of typical plasma-etching systems, the advantages of plasma-etching over wet-chemical methods, and the control of plasma processes.

This bulletin doesn't discuss any process in detail, or give operating parameters for any process. Detailed discussions of individual plasma-etching processes appear in the Dionex Operating Bulletins, which are available to our customers without charge.

Plasma Principles

Plasma sometimes is called "the fourth state of matter." A plasma resembles a gas in many ways, but with an important difference: The particles (atoms or molecules) of a gas are uncharged and electrically neutral. In a plasma, some fraction of the particles have been ionized and carry electric charges. Positive and negative ions are present in the plasma in roughly equal numbers.

The plasma also may contain a substantial population of free radicals. A free radical is an electrically neutral, highly reactive atom or group of atoms.

The presence of ions and free radicals in a plasma makes the plasma very reactive—so reactive, in fact, that it is unstable. Unless energy is supplied continuously to maintain the plasma, it will degenerate quickly into an ordinary gas. This is why lightning—a natural plasma—is so short-lived.

This extreme reactivity is the key to the commercial application of plasmas in various industries. Plasmas are used in chemical milling, in the nitriding of steel, in the synthesis of organic polymers, in the modification of polymers surfaces, and in the deposition and hardening of organic coatings and films.

But the most important applications of plasma processing (measured by the value of the materials processed) occur in microelectronics manufacturing. Plasmas are used not only for etching but also for cleaning, de-scumming, stripping and passivating delicate wafers and masks.

Plasma-Etching Systems

Plasma-etchers are simple and reliable. Each system has three basic units: a **reactor,** which holds wafers during etching; a **radio-frequency (RF) generator,** which supplies energy for creating plasmas inside the reactor; and **control equipment,** housed in one or two modules.

After the reactor has been loaded with wafers, it is evacuated by a mechanical pump. Then a **reagent gas** enters the reactor and is ionized to form an etching plasma. Fresh reagent gas flows into the reactor continuously during etching, while gaseous reaction products are withdrawn from the reactor by a vacuum pump.

The reagent gases used most often are oxygen, silicon tetrafluoride (SiF_4) and various Freons. Freons are halogenated carbon compounds, such as CF_4 and C_2F_6.

In many etching processes, the reagent gas is a mixture. The most common commercial mixtures are oxygen/CF_4 and oxygen/SiF_4.

During a typical process, the plasma system's control module governs five variables: the composition of the reagent gas; the flow-rate of the reagent gas; the RF power; the pressure in the reactor; and the processing time. These parameters define the etching process. Their values—and the precision with which they are controlled—determine how effective the process will be.

Plasma-etching doesn't require the use of unusual photoresists or coatings. The same photoresists and coatings that are used in wet-chemical etching are used in plasma-etching.

Reactor Design

There are two kinds of plasma reactors: cylindrical and planar. They differ substantially in their design and in their etching performance.

Cylindrical Reactors

In a cylindrical reactor, wafers stand erect during etching, in racks made of quartz or aluminum. The wafers aren't exposed directly to the etching plasma. Etching is done by free radicals that migrate out of the plasma to reach the wafers.

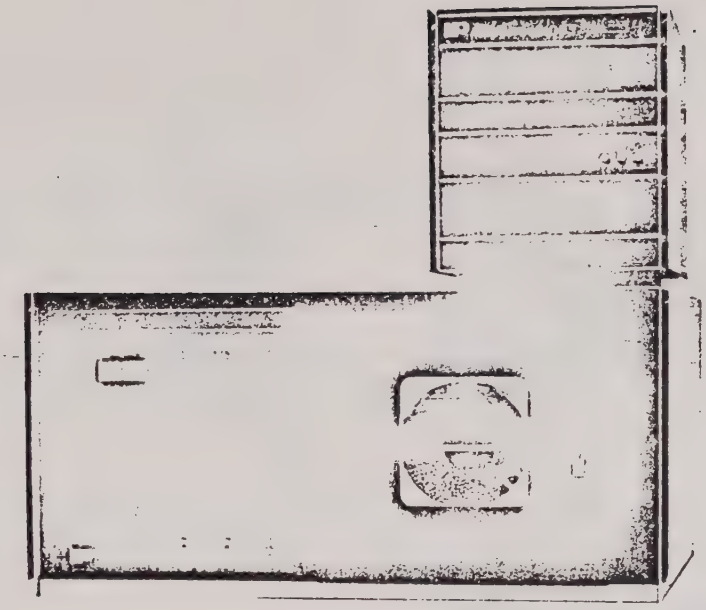


Figure 1

A Dionex plasma-etcher with a cylindrical reactor. A rack of wafers is visible through the reactor door. The unit atop the controller includes the system's RF generator.

Figure 1 shows a cylindrical reactor loaded with wafers. Notice that the rack of wafers stands inside a cylindrical, perforated-metal shield—the Etch-Tunnel cylinder.*

Figure 2 is a highly simplified diagram of the reactor, showing how it works. The reagent gas is introduced through the bottom of the reactor and flows toward the gas exhaust. As soon as the gas enters the reactor, RF energy from the upper and lower electrodes converts the gas into a plasma. In the diagram, the plasma is shown as a stippled area. The Etch-Tunnel cylinder restricts the plasma to the region between the cylinder and the reactor wall. If there were no cylinder in this system, the plasma would fill the entire reactor.

The plasma region contains various reactive entities—ions, free electrons, strong electric fields, intense ultraviolet radiation and free radicals. Only the free radicals are needed for etching. It is generally believed that the ions, electric fields and UV radiation aren't useful in etching, and that they can cause harmful overheating of the wafers. Overheating can degrade photoresist, damage wafers and make the etching difficult to control.

These ions, electric fields and radiation occur within the plasma only; they *can't* leave the plasma region. By creating a plasma-free space around the wafers, the Etch-Tunnel cylinder protects the wafers from these entities.

Free radicals, however *can* leave the plasma region. They pass through the perforations in the Etch-Tunnel cylinder, strike the wafers and promote etching reactions. The products from these reactions pass through the perforations and into the plasma region, to be withdrawn through the gas exhaust.

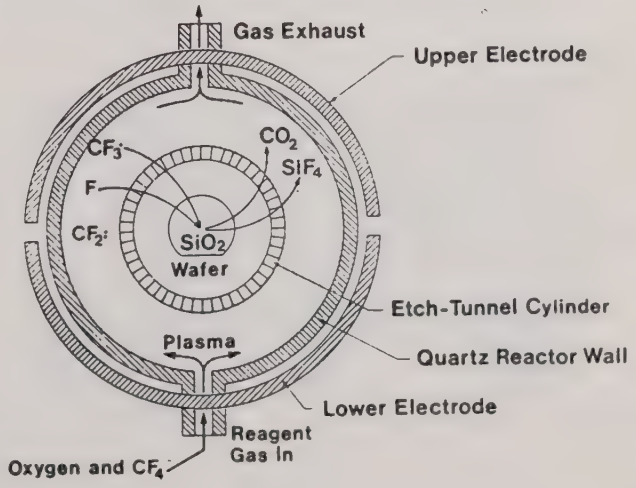


Figure 2

A cross-section of a cylindrical reactor during etching. This diagram is explained in the text on this page.

***This shield was developed by Dionex. *Etch-Tunnel* is a registered trademark of Dionex.**

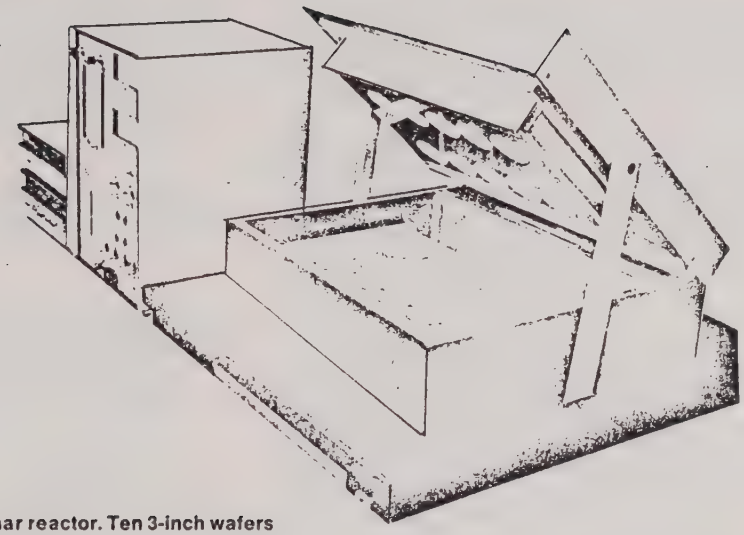


Figure 3

A Dionex plasma-etcher with a planar reactor. Ten 3-inch wafers are lying on the reactor's lower electrode.

All of these events are illustrated in Figure 4, which shows the etching of a layer of silicon dioxide (SiO_2) in an oxygen/CF_4 plasma. The free radicals CF_3· and F· are the chief etching agents. The radical CF_2: also occurs in oxygen/CF_4 plasmas, but it isn't important in the etching of SiO_2.

Planar Reactors

In a planar reactor, wafers lie side-by-side on a flat, rectangular plate. This plate is the lower of two electrodes that create plasmas in the reactor. The upper electrode is a plate that hangs from the top of the reactor, about 1 inch above the wafers.

Figure 3 shows a planar reactor with its top raised, to display the load of wafers on the lower electrode.

Figure 4 is a section through the closed reactor during etching. The reagent gas enters the reactor from a manifold under the center line of the lower electrode. Reaction products leave through exhaust manifolds near the front and rear edges of the reactor. Both electrodes are water-cooled, to keep the wafers at a specified, constant temperature during etching.

A vital feature of the planar reactor is the upper electrode. The **focusing plate** on the face of this electrode produces a concentrated etching plasma that is directed at specific sites on the lower electrode. Wafers lie at these sites during etching.

Notice that the wafers are within the plasma region and exposed directly to the plasma. This merits explanation, because the preceding discussion of cylindrical reactors emphasized that a plasma generates ions, electric fields and radiation that can overheat wafers. In a planar reactor, overheating can't occur: The entire underside of every wafer touches the water-cooled lower electrode, and the whole wafer is kept at the temperature of the electrode.

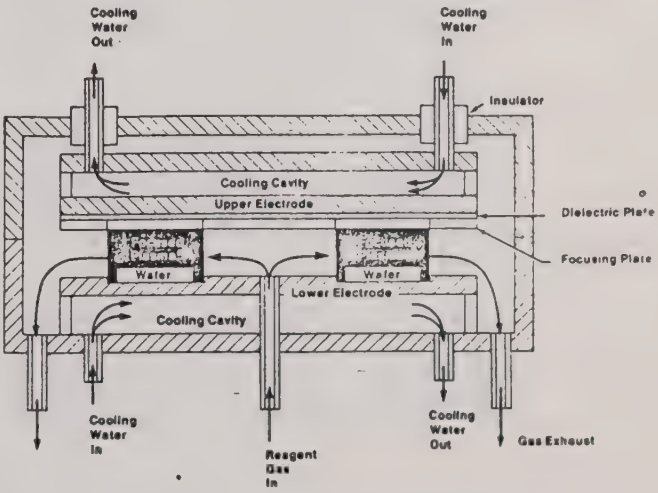


Figure 4

A longitudinal section through a planar reactor during etching. For explanation, see the text on this page.

Effect of Reactor Design on Etching

There is an important difference between etching done in a cylindrical reactor and etching done in a planar reactor.

In a cylindrical reactor, etching is **isotropic:** It proceeds vertically and laterally at similar rates, so that an etched line grows narrower as it grows deeper. The narrowing of the line is called **undercutting.** It can cause the etched line to become significantly narrower than the corresponding line in the photoresist pattern. Isotropic etching and undercutting are illustrated in Figure 5.

In a planar reactor, etching is **anisotropic:** Vertical etching proceeds rapidly, but lateral etching is very slow. As a result, undercutting is negligible or imperceptible. Anisotropic etching is shown in Figure 6.

For etching broad, widely spaced lines, isotropic etching in a cylindrical reactor can be quite satisfactory. But for etching narrow lines—lines whose width is about equal to the thickness of the layer being etched—anisotropic etching in a planar reactor is required.

For this reason, Dionex usually recommends planar reactors for etching dense patterns and for etching lines whose width is less than 5 microns.

Generally, an etcher that has a planar reactor costs 20% to 40% more than a cylindrical-reactor system having the same capacity and process capabilities.

Advantages of Plasma-Etching

In all of its applications to microelectronics manufacturing, plasma-etching offers important advantages over wet-chemical etching.

First: Reagent gases, such as oxygen and the Freons, are harmless to handle and are available in cylinders that can be shipped, stored and used without danger. This isn't true of the corrosive chemicals that are used in wet etching.

Second: Plasma-etching can provide finer resolution, with less undercutting, than wet etching can. No wet process offers the high accuracy and negligible undercutting that typify plasma-etching in a planar reactor. Even plasma-etching in a cylindrical reactor causes less undercutting and provides more precision than comparable wet processes do. Figure 7 and Figure 8 illustrate this.

Third: Plasma systems can clean, etch and strip wafers sequentially, in the same reactor. A typical sequence involves three steps: The wafers are de-scummed by brief exposure to an oxygen plasma; then they are etched in an oxygen/SiF_4 plasma; then they are stripped in another oxygen plasma. These three steps are performed automatically, without manual control. The wafers aren't handled between the steps, so they aren't exposed to contamination or damage.

Fourth: Plasma-etching creates almost no pollution problems. It releases little, if any, smoke or fumes into the factory environment. It is virtually silent. And it doesn't generate the large volumes of waste chemicals that typify wet processes.

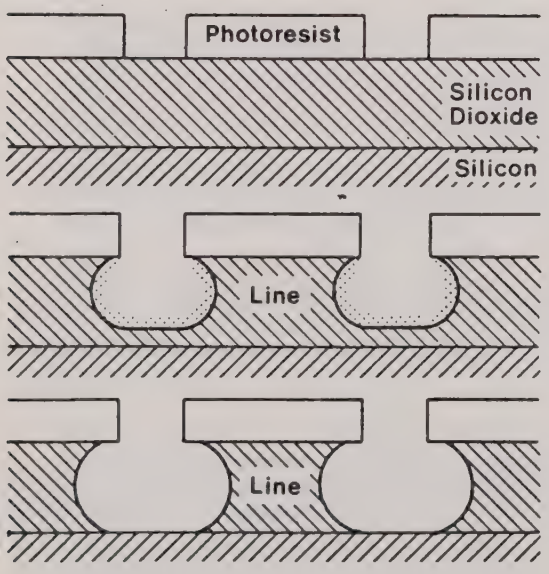


Figure 5

Isotropic etching of a line through a layer of silicon dioxide. The stippling in the middle drawing shows where etching is occurring. As the channels adjacent to the line grow deeper, undercutting makes the line grow narrower. As a consequence, the finished line of oxide is considerably narrower than the corresponding line in the photoresist pattern.

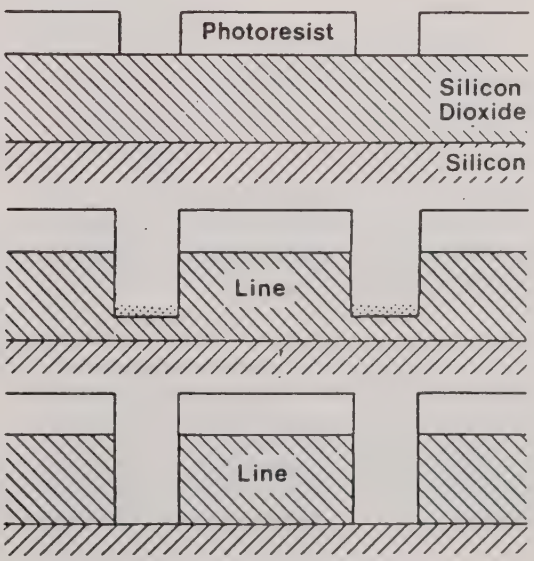


Figure 6

Anisotropic etching of a line through a layer of silicon dioxide. The stippling indicates that etching is taking place only at the bottoms of the adjacent channels. The sides of the channels aren't being etched, so the line isn't growing narrower. The width of the etched line of silicon dioxide is the same as the width of the line in the photoresist pattern.

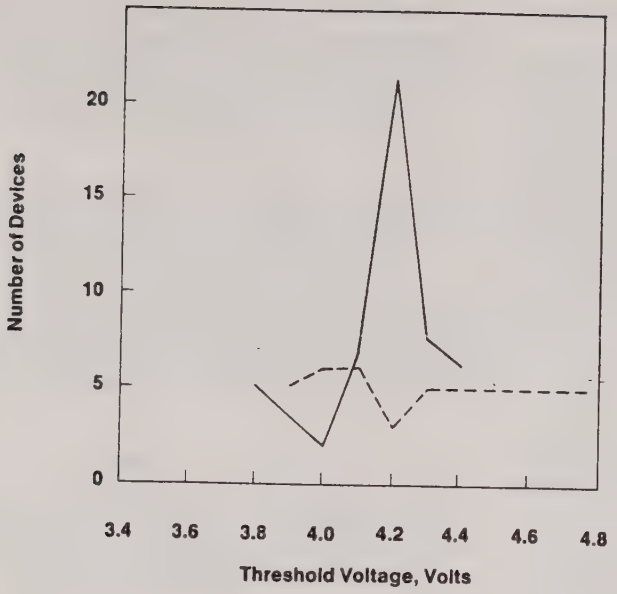


Figure 7

Distribution of threshold voltage in MOS transistors whose silicon nitride was etched with plasma (solid line) or with wet chemicals (broken line). The narrow distribution of voltage in the plasma-etched devices illustrates the greater reproducibility and precision of plasma-etching. *Redrawn from a figure by H. Abe in Proc. 6th Conference on Solid-State Devices, J. Japan Soc. Applied Physics 44: 287-295.*

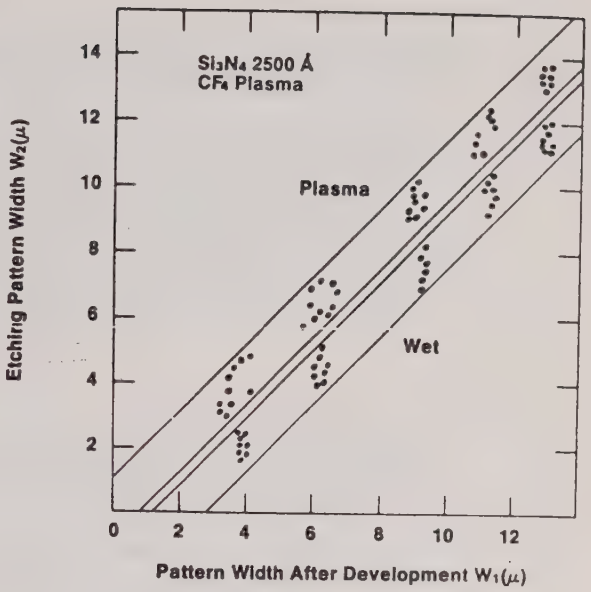


Figure 8

Accuracy of plasma-etching and wet-chemical etching in creating isolated lines of silicon nitride. Wet etching (triangles) caused undercutting: Etched lines are consistently narrower than the lines on the photoresist, by about 2 microns. Plasma-etching data (circles) show little difference between width of an etched line and the width of the photoresist line. *Redrawn from the source cited for Figure 7.*

Fifth: The cost of reagent for a plasma-etching process is markedly lower than the cost of reagent for a wet process. In a wet process, the reagent solution is used not only for etching wafers but also for sweeping away the products of the etching reactions. For this reason, the typical wet process requires excess reagent in huge amounts; a kilogram of reagent may be used in a process that removes micrograms of material from a batch of wafers. In plasma-etching, the reagent excess is modest. An example will demonstrate this:

Suppose that a silicon dioxide layer must be etched to a depth of 5,000 angstroms in an oxygen/CF_4 plasma. If the reactor is loaded with 25 three-inch wafers, about 1×10^{21} CF_4 silicon atoms must be converted to SiF_4 and removed from the wafers during etching.

One molecule of CF_4 will supply the fluorine atoms needed for converting one atom of silicon to SiF_4. Hence, 1×10^{21} CF_4 molecules must be changed into radicals that actually participate in etching reactions.

A typical flow-rate of CF_4 during the etching of silicon dioxide is 100 milliliters per minute (measured at standard temperature and pressure). At this flowrate, about 2×10^{21} CF_4 molecules enter the reactor each minute, and we can assume that 10% of these molecules are converted to useful free radicals.

If all of these radicals enter into etching reactions, 1×10^{22} CF_4 molecules will be consumed during the removal of 1×10^{21} silicon atoms, and the etching will take about 5 minutes.

Etching Rates

The etching rate obtained in a plasma process usually is expressed in angstroms per minute. It tells the depth of the new etching accomplished in 1 minute, under specified process conditions.

The process factors that have the strongest effects on etching rates are: the chemical nature of the material being etched; the number of wafers (wafer load) in the reactor; the temperature of the wafers; and the rate of free-radical-generation.

Effect of Materials

Because etching rates are influenced by several interacting factors, it is impossible to state the *absolute* etching rate (in angstroms per minute) that will prevail during the etching of a specific material. The table on the next page shows some *relative* rates, which indicate how rapidly various materials can be etched under identical or comparable process conditions.

Effects of Wafer Load

In a cylindrical reactor, typical loads range from 25 to 100 wafers. As the load increases, the etching rate decreases. Here is the reason for this:

The average residence time of a gas molecule or a free radical in a cylindrical reactor is relatively long. A typical radical stays in the reactor for many seconds *after* it has participated in an

etching reaction, and thus has become unreactive. Some percentage of the radicals that reach a given wafer are these unreactive radicals that already have etched some other wafer. Clearly, this percentage increases as the number of other wafers increases. The etching rate decreases accordingly.

In a planar reactor, typical loads range from 10 to 25 wafers. The size of the load has almost no effect on etching rate. The average residence time of a radical in a planar reactor is very short. A typical radical is withdrawn from the reactor immediately after it has reacted with a wafer; it doesn't visit other wafers. For this reason, nearly all of the radicals that reach a given wafer are reactive radicals. The etching of the given wafer isn't affected by the presence of other wafers, so the etching rate isn't affected by the size of the wafer load.

Importance of Temperature

Since etching is a chemical process, it isn't surprising that temperature affects the etching rate. In typical commercial processes, the etching rate increases by 1% to 2% when the temperature rises by 1 Centigrade degree.

Importance of Free-Radical-Generation

Free radicals are the actual reagents in plasma-etching, and the etching rate depends on the plasma's ability to generate them. The creation of large numbers of free radicals is especially important during etching in a cylindrical reactor: The plasma must be rich in radicals, so that a substantial number can leave the plasma region and migrate to the wafers. The rate of free-radical-generation depends on two process parameters: the RF power and the composition of the reageant gas.

Material	Relative Etching Rate in Etch Tunnel
In oxygen/SiF_4 plasmas	
polycrystalline silicon	250
silicon dioxide	30
silicon (111)	300
silicon nitride, plasma	1100
silicon nitride, LPCVD	200–400
In oxygen/CF_4 plasmas	
silicon nitride, LPCVD	200–400
silicon nitride, plasma	1100
silicon dioxide	200
silicon (111)	1000–1500
polycrystalline silicon	1000–1500

Relative etching rates of some microelectronic materials when they are etched in a cylindrical reactor. This table is based on data collected at Dionex's laboratories. A Dionex Etch-Tunnel cylinder was used in all of the experimental work.

RF Power

The radicals in an etching plasma are created when electrons collide with molecules of the reagent gas. The electrons are supplied in the current delivered by the RF generator. As RF power increases, this current becomes stronger and more electrons are available for productive collisions.

Reagent Gas

Under identical conditions, different gases and gas mixtures create free radicals at different rates. Here is one example:

Pure CF_4 can be ionized to create a useful etching plasma, but the plasma is relatively poor in fluorinated free radicals. A mixture of CF_4 and oxygen produces a much richer plasma that generates free radicals about 10 times more rapidly than a pure CF_4 plasma does. In the oxygen/CF_4 plasma, free-radical generation proceeds in two steps: Electrons collide with oxygen molecules to produce free radicals of oxygen (such as O·), then the oxygen radicals react with CF_4 to generate fluorinated radicals for etching.

Process Control

Commercial etching requires close control of etching rates. The preceding text pointed out that etching rates depend chiefly on the material being etched, the wafer load, the wafer temperature and the generation of free radicals.

For a given process, the material being etched is a constant, and the wafer load can be governed easily and directly. The control of free-radical generation and the control of temperature require further discussion.

Controlling Free-Radical-Generation

After the reagent gas has been specified, the rate of free-radical-generation depends almost entirely on the RF power. The power must be kept at an optimal value during etching, and it must be very stable.

To refine the control of RF power, Dionex has developed two proprietary control units. Both can be incorporated into any IPC plasma-etching system.

The first of these units provides electronic stabilization of RF power itself. The chief external cause of variation in RF power is variation in line voltage. Fluctuations as large as 10% are common. At the RF-power levels used in plasma-etching (150 to 1000 watts), a 1-watt fluctuation in power can cause a 1% change in the etching rate.

The second unit for controlling RF power is Dionex's AutoMatch 2 impedance-matching apparatus, which automatically and continuously equalizes the impedance of the etching plasma and the impedance of the RF generator. This matching is crucial: Any change in the relation between the two impedances alters the etching rate, just as a power fluctuation does.

Controlling Temperature

The importance of temperature-control can be comprehended most easily by considering the three kinds of variations that are found in etched wafers:

Across-wafer variation describes differences in the nature and the extent of etching at different points on the same wafer.

Wafer-to-wafer variation embraces differences between two wafers that were etched during the same run of an etching process.

Run-to-run variation denotes differences between two wafers that were etched during different runs of the same process.

In any process, these variations must be minimized. And all of them are affected by temperature.

Temperature and Across-Wafer Variation

Across-wafer variation is caused chiefly by local temperature differences on the wafer during etching.

In a planar reactor, these differences are insignificant. The temperature of each wafer is constant and uniform, because the entire underside of the wafer touches the water-cooled lower electrode.

In a cylindrical reactor, across-wafer temperature differences will be large if no Etch-Tunnel cylinder is used. Ions and radiation within the plasma will concentrate their energy on the periphery of each wafer and overheat it. Peripheral regions of the wafer may be severely over-etched while the center of the wafer remains under-etched.

These effects are prevented entirely by using the Etch-Tunnel cylinder to shield the wafers from the plasma.

Temperature and Wafer-to-Wafer Variation

Variation among wafers etched during the same process run is caused almost wholly by wafer-to-wafer temperature differences.

In a planar reactor, such differences can't arise: All of the wafers have the same temperature as the lower electrode.

But in a cylindrical reactor, some wafers may be heated more than others, for two reasons: There may be "hot spots" at certain places within the etching plasma; and wafers near the ends of the reactor may become unusually hot, because the ends of the reactor concentrate heat.

Dionex's cylindrical reactors have been designed to minimize wafer-to-wafer temperature differences. Each reactor creates an extraordinarily uniform plasma without hot spots, and each has multiple ports for the injection of reagent gas and the withdrawal of reaction products. These multiple ports encourage a uniform flow of gases through the reactor. Moreover, the Etch-Tunnel cylinder suppresses wafer-to-wafer temperature differences by equalizing the flow of heat and free radicals throughout its interior.

Temperature and Run-to-Run Variation

Temperature differences are an important cause—but not the only cause—of variation among wafers etched during different runs of the same process. To minimize run-to-run variation, the process engineer must make sure that all wafers in all runs have the same **initial temperature** when etching begins, and that they remain at the same temperature during etching.

In a planar reactor, this can be ensured easily: The temperature of the lower electrode is under automatic control, and can be kept at any specified temperature before and during etching.

In a cylindrical reactor, run-to-run temperature control requires some special tactics:

Consider first the simplest cylindrical-reactor systems. In these systems, the etching plasma is established as soon as the reactor has been sealed and evacuated, regardless of the initial temperature of the wafers. This temperature can vary considerably from run to run, since it depends on the recent histories of the reactor and of the wafers.

To equalize the initial temperature during all runs of a process, Dionex has developed temperature controllers for cylindrical reactors. In systems that have these controllers, the reactor and the wafers are heated to a specified temperature before the etching plasma is established. The heating is done by an inert plasma—a plasma that generates heat but doesn't react with any substance on the wafers. The gases used most often for creating inert plasmas are nitrogen and argon.

A typical Dionex cylindrical reactor system with a temperature controller can restrict run-to-run variation to 5% or less. In systems without temperature controllers, variation usually is between 10% and 30%.

Chemically Selective Processes

The ideal etching is chemically selective: It etches one material only, and it can't attack other materials that might be exposed to the etching plasma. Such a process forgives process-control errors. Even if the process is allowed to run for an excessively long time, it can't damage wafers.

Not all plasma-etching processes are chemically selective, but several such processes have been developed. Some are **absolutely selective** and some are **preferential.** An absolutely selective process etches one substance and leaves all others completely unaffected. A preferential process etches one substance very strongly but has only mild effects on others.

Selective processes exist for etching aluminum, silicon dioxide, silicon nitride, polycrystalline silicon, chromium, tungsten and several other materials. Here are brief descriptions of five of these processes:

DryAl Etching of Aluminum

This preferential process was developed by Dionex, and *DryAl* is a registered trademark of Dionex. The DryAl process is used for etching thin aluminum layers to form conducting patterns within circuits and between circuits. Etching must be done in a planar reactor. The reagent gas is a mixture of helium and carbon tetrachloride (CCl_4).

DryAl etching is done in two stages: a high-power step to etch through the aluminum oxide on the surface; and a low-power step to finish the etch. The power reduction maintains a high rate of aluminum etch but drastically reduces the etch rates of silicon dioxide and silicon.

The etching rate of single-crystal silicon under DryAl conditions is about 1½% of the etching rate of aluminum.

Planar Etching of Polysilicon

The high-power etch conditions used in the first stage of aluminum etching can also be used very advantageously for selectively etching polysilicon. The selectivity of polysilicon over silicon dioxide is better than 10 to 1. And the anisotropic nature of the etch produces straight walls with no undercutting.

Etching Silicon Dioxide in a Freon Plasma

One of the most common configurations in microelectronic devices is a layer of silicon dioxide atop a layer of silicon. Etching a window through the oxide is a delicate task, because most oxide-etching processes can etch silicon too. These

Figure 9

An aluminum pattern, 1 micron thick, etched by the DryAl process. The smooth material under the aluminum is silicon dioxide. The magnification here is about 5000X.

Figure 10

These numerals are parts of an oxide pattern produced by DryOx etching. The oxide, 1 micron thick, lies on a substrate of silicon. The magnification here is 5000X.

processes require very close control. Etching must be stopped as soon as the oxide has been removed, before the plasma can attack the underlying silicon.

Now Dionex has developed a preferential process that eliminates danger to the silicon. Etching is done in a planar reactor. The reagent gas is C_2F_6. At the prescribed temperature and pressure, the etching rate of oxide is about 15 times greater than the etching rate of silicon.

DryOx Etching of Silicon Dioxide

This process too was developed and patented by Dionex. *DryOx* is a registered trademark of Dionex. The DryOx process has the same purpose as the preceding process does: etching through silicon dioxide on top of silicon. But DryOx etching is done in a special system that has a cylindrical reactor; and DryOx etching is absolutely selective: Under DryOx conditions, the etching rate of silicon is exactly zero. After the oxide layer has been removed, etching stops completely.

Etching Silicon Nitride in an Oxygen/SiF_4 Plasma

This process, performed in a cylindrical reactor, is used for etching nitride that lies atop silicon. Because an oxygen/SiF_4 plasma minimizes the etching of exposed silicon, it is markedly safer to use than is an oxygen/CF_4 plasma.

In an oxygen/CF_4 plasma, the etching rate of single-crystal silicon is about 7 times greater than the etching rate of nitride, and the etching rate of polycrystalline silicon is about 10 times greater. For this reason, oxygen/CF_4 plasmas often are impractical for etching nitride. Even with close control, occasional batches of wafers are ruined when the plasma is allowed to reach the silicon.

In an oxygen/SiF_4 plasma, the etching rates of single-crystal and polycrystalline silicon are about the same as the etching rate of nitride. Although this plasma isn't truly preferential for nitride, its relatively mild effect on silicon represents a selectivity unavailable in any other nitride-etching process.

BRANSON/IPC
a SmithKline company
Gas Plasma Systems
31159 San Benito Street, P.O. Box 4136, Hayward, CA 94544
(415) 489-3030, Telex: 337-759

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

Plasma-Etching Silicon Nitride

Silicon nitride (Si_3N_4) is used widely in the manufacture of microelectronics devices, to form dielectric layers or passivation films. A passivation film is a layer that protects underlying materials from contamination.

There are three important commercial methods for depositing silicon nitride films: pyrolytic deposition, plasma deposition, and low pressure chemical vapor deposition (LPCVD). All three types can be successfully plasma etched, although the etching characteristics vary according to film type.

Advantages

In the etching of silicon nitride, the only important alternative to plasma-etching is wet etching with hot phosphoric acid. This process involves a hazardous, corrosive reagent; etching reactions that are hard to control; and large volumes of chemical wastes. And since hot phosphoric acid degrades most commercial photoresists, the etching pattern must be controlled by an oxide mask. Such masks are made by a multiple-step etching process that exposes wafers to extra handling and breakage.

Plasma-etching offers none of these drawbacks. It employs inexpensive gases as reagents; it can be controlled easily and precisely; it produces no noxious wastes; and it is more accurate and more uniform than wet-chemical etching.

Barrel Reactor

Operation

Silicon nitride can be etched by either a Freon 14 (CF_4) and oxygen plasma or a silicon tetrafluoride (SiF_4) and oxygen plasma. The process is generally performed in a Dionex etch tunnel.

Here are typical values for process variables in the etching of silicon nitride films with different etch mixtures.

Freon 14 with 4% or 50% oxygen

Temperature	Preheat to about 80–120°C
Pressure	0.3–0 5 Torr for 4% oxygen mixture 0.8–1.2 Torr for 50% oxygen mixture
Power	50–200 Watts for 8"x18" chamber 75–250 Watts for 10"x18" chamber
Pumping	About 500 liters/minute for 8"x18" chamber About 675 liters/minute for 10"x18" chamber
Etch Rate	Pyrolytic and LPCVD nitride—200–400 Å/minute Plasma nitride—500–1000 Å/minute
Spacing	Wafers must be at least ⅜-inch apart (wide spacing favors uniform etching)

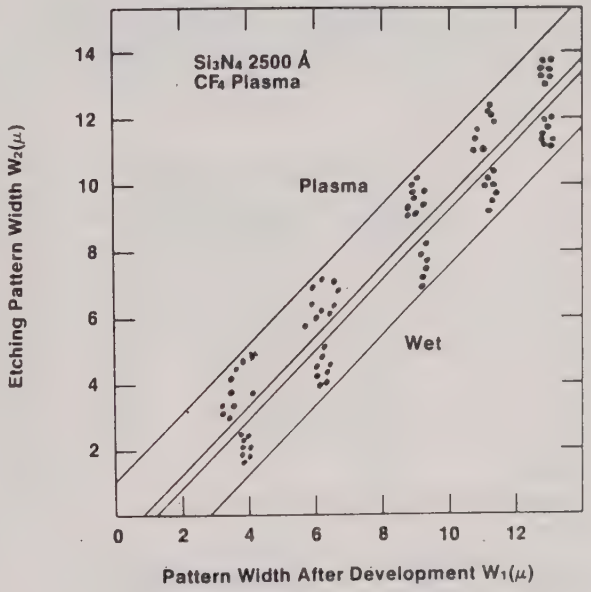


Figure 1

Comparison of plasma and wet-chemical methods in etching isolated tongues of silicon nitride. Data for plasma-etching are clustered along the diagonal; there were virtually no differences between the widths of lines on the photoresist and the Si_3N_4 tongues generated from those lines. Data for wet etching show significant undercutting of the photoresist: etched tongues were narrower than the lines on the photoresist. *From H. Abe, 1974. Proc.6th Conf. Solid State Devices, J. Japan. Soc. Appl: Phys. 44:287–295.*

Silicon tetrafluoride (SiF_4) with 4% oxygen

Temperature	80–120°C
Pressure	0.7–1.2 Torr
Power	150–250 Watts for 8"x18" chamber 250–350 Watts for 10"x18" chamber
Pumping	About 500 liters/minute for 8"x18" chamber About 650 liters/minute for 10"x18" chamber
Etch Rate	Pyrolytic and LPCVD nitride—150–300Å/minute Plasma nitride—800–1000 Å/minute
Spacing	Wafers must be at least ⅜-inch apart (wide spacing favors uniform etching)

This publication is part of a series of Dionex Operating Bulletins that describe applications of plasma in the manufacture of semiconductor devices. Each bulletin covers a single plasma-etching or plasma-stripping process. General information about plasma systems in microelectronics manufacturing can be found in *Bulletin 70001 Fundamentals of Plasma-Etching.*

Process Control

The control of the etching process depends partly on the other materials that will be exposed to the etching plasma. For example, GaAsP is impervious to Freon-oxygen plasmas, and the etching of a nitride film that lies on a GaAsP layer isn't a critical process. Even after the nitride has been etched away, the GaAsP cannot be damaged by the plasma.

Silicon, on the other hand, is attacked vigorously by Freon/oxygen plasmas. Therefore, the etching of silicon nitride film atop a layer of silicon demands precise control. If the process isn't terminated promptly, the plasma can damage the underlying silicon severely.

Such a critical process requires a gas mixture that will maximize the etching of silicon nitride and minimize the etching of other materials. The table below shows the relative etching rates of some materials in the two gas mixtures that commonly are used in etching silicon nitride.

Material	Relative Etching Rates		
	with 4% O_2	with 50% O_2	In SiF_4/O_2
Silicon nitride, LPCVD	1.0	1.0	1.0
GaAsP	0.0	0.0	**
Aluminum	0.0	0.0	0.0
Silicon dioxide (thermal)	0.4	0.3	0.2
Silicon (111)	6.9	0.6	1.0
Silicon (poly)	9.9	0.6	1.0
Negative resist	0.2	2–50	0.2
Positive resist	0.4	2–50	0.4
Undoped CVD oxide	1.2	1.2	**
Doped CVD oxide	3.0	3.0	**

* Using the Dionex Etch-Tunnel cylinder in all cases.
** Not available.

For the etching of silicon nitride atop silicon, a two-step process can be used. In the first step, a 4%-oxygen mixture is used for removing about 90% of the nitride film. Then the etching is completed with a 50%-oxygen mixture, which etches silicon nitride more slowly than 4%-oxygen, but will not ruin the underlying silicon. This two-step process limits the etching of silicon to about 2% of the depth of the original nitride layer.

The disadvantage of using a 50% oxygen and CF_4 mixture is that the erosion rate of photoresist goes up with the oxygen content. When selectivity is important, it is recommended that a SiF_4/O_2 gas mixture be used as the etch gas. The etch ratio given in the above table can be further improved by using a helium-diluted SiF_4/O_2 mixture.

In general, critical nitride-etching processes require the close control provided by Dionex 2000T and 8000T etcher/strippers. These are temperature-controlled plasma systems: they use a preheating step to make certain that all wafers, in all runs, have the same temperature and thermal history when etching begins. Information about these systems appears in *Product Bulletin 7408 and Product Bulletin 7409*. The Dionex 9000, the most advanced barrel plasma system available, is capable of storing sixteen complete and separate programs, each with up to sixteen individual steps. *Refer to Product Bulletin 9000/79.*

Special Considerations

• Fast-Etching Films

All nitride films that are especially thin or unusually silicon-rich will be etched very rapidly by Freon/oxygen plasmas. Excessively fast etching is neither accurate nor uniform in its effects. For this reason, the etching process must be adjusted so that it takes at least three minutes to complete. The easiest way to slow the etching of silicon nitride is to use a low pressure, low power condition or a diluent such as helium or nitrogen. A recommended diluted gas mixture for etching silicon-rich films contains 75% nitrogen (or helium), 24% Freon 14 and 1% oxygen.

• Using SiF_4

Silicon tetrafluoride is a toxic gas that reacts rapidly with moisture to form HF, a corrosive and toxic gaseous compound. SiF_4 by itself is not corrosive unless combined with water. Special care must be taken to keep the chamber leak-tight to prevent possible hydrolysis of SiF_4 and its escape into the atmosphere. Special safety features are built in Dionex barrel systems that are to be used with SiF_4.

• Protecting Backs of Wafers

During any process for etching silicon wafers, the plasma must be restrained from attacking the backs of the wafers. There are two reasons for this. First, rapid etching of the wafer backs will heat the wafers, making process-control difficult. Secondly, the backs of the wafers will absorb large numbers of reagent particles, slowing or even stopping the etching of the nitride on the front surfaces of the wafers.

Four methods are available for protecting wafer backs: oxidizing them, coating them with photoresist, shielding them with aluminum plates, or arranging the wafers so that they stand back-to-back during etching.

Planar Reactor

Operation

Silicon nitride can be etched in a planar etcher using C_2F_6 (Freon 116) and other gases. If the nitride is on an oxide layer which is to be selectively etched down to the silicon, the nitride and oxide can be etched in a single step using the same parameters. If the nitride is on silicon, the selectivity is better than that obtained in a barrel reactor. Planar etching is anistropic, producing straight walls and no undercutting.

Etch Rates — Planar Reactor

	Å/min.
LPCVD Si_3N_4	200–300
Pyrolytic Si_3N_4	200–350
Plasma Si_3N_4	150–200
Thermal SiO_2	200–350
Silicon (100) and (111)	30–40

Process Control

The Dionex 5200 and 5400 planar etchers provide precise control over all parameters: (temperature, mass flow, pressure, and power) necessary to obtain uniform and reproducible results.

BRANSON/IPC
a SmithKline company

Gas Plasma Systems
31159 San Benito Street, P.O. Box 4136, Hayward, CA 94544
(415) 489-3030. Telex: 337-759

BRANSON INTERNATIONAL PLASMA CORPORATION
72 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

Plasma-Etching Polycrystalline Silicon in a Barrel Reactor

Polycrystalline silicon is a common material in microelectronic devices. It appears most often in semiconductive layers that are 3,000 to 5,000-Å thick. It also is used to construct conductive layers in transistors and other circuit elements. Such layers are about 1,000-Å thick.

The most important commercial method for depositing films of polycrystalline silicon is the thermal decomposition of silane (SiH_4).

The Plasma-Etching Process

Advantages

In the etching of polycrystalline silicon, the only important alternative to plasma-etching is wet etching with a mixture of two powerful mineral acids—hydrofluoric and nitric. The process is inherently dangerous and hard to control, and it generates large volumes of waste chemicals whose disposal can be costly.

Plasma-etching presents none of these problems. It employs inexpensive gases as reagents; it can be controlled easily and precisely; and it is more accurate and more uniform than wet-acid etching.

Operation

The reagent mixtures that are commonly used in the plasma-etching of microelectronic materials are Freon 14 (CF_4) and oxygen or silicon tetrafluoride (SiF_4) and oxygen. Plasmas formed from these mixtures are rich in fluorinated active species that are capable of reacting with the surface of workpieces to perform the required etching.

CF_4/O_2

Polycrystalline silicone can be etched very rapidly by Freon/oxygen plasmas. And etch rates as high as 3000Å are easily obtained. Such fast etching, however, is not desirable because it is difficult to control and can cause severe undercutting and non-uniform etch patterns. Control of the process is achieved by slowing down the etch rate by adding an inert diluent such as helium or nitrogen to the etch gas, or by reducing the pressure and power.

The Dionex etch tunnel is generally used in the etching of polycrystalline silicon with CF_4/O_2. The tunnel protects the wafers from possible radiation damage and enhances uniform etching.

For practical purposes, the etching of polycrystalline silicone with CF_4/O_2 is an isotropic process (one that proceeds in all directions through the silicon layer). This properly limits the pattern geometry which can be processed by this means. (See Figure 1.)

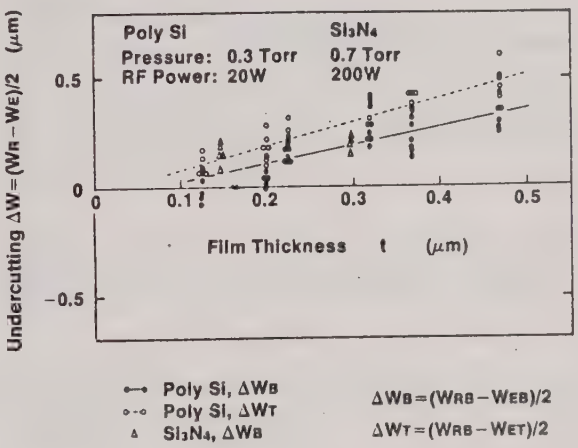


Figure 1

Isotropic etching of polycrystalline silicon. The extent of undercutting always is comparable to the thickness of the etched film, indicating that etching proceeds at virtually the same rate in all directions through the silicon. This relationship doesn't hold during the etching of silicon nitride. *From H. Komiya et al., Proc. 7th Conf. Solid State Devices: pages 19–24. Japan Soc. Appl. Phys.*

SiF_4/O_2

This gas mixture offers the possibility of etching polycrystalline silicon in the barrel reactor anisotropically, thus allowing wafers with small geometric patterns to be etched in the more economical barrel reactors.

Etching of polycrystalline silicon with SiF_4/O_2 can be either with or without the etch tunnel. An etch rate of 300–1000Å/minute can be obtained, depending on specific conditions. When etching is done without the etch tunnel, anisotropic etching with minimal undercutting is obtained. Geometries can be held to <0.1 micron when etching 0.5 micron films. Figures 2 and 3 show the comparison between 100% overetched identical polysilicon samples using CF_4/O_2 and SiF_4/O_2 mixtures.

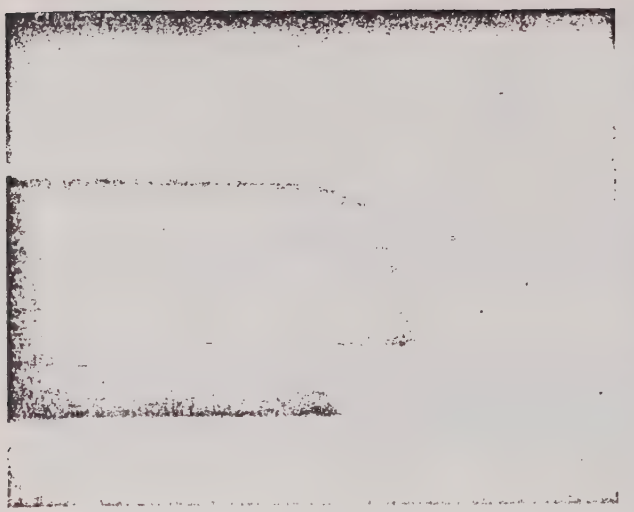


Figure 2 **20,000X**

CF_4 etched polysilicon with undercutting.

Figure 3 **20,000X**

SiF_4 etched polysilicon with significantly less undercutting.

Process Variables

Here are representative values for process varibles in the etching of polycrystalline silicon films, using the Etch-Tunnel cylinder.

CF_4/O_2

Temperature	Preheat to 80–100°C
Gas	Freon 14 (96%), oxygen (4%)
Pressure	0.25–0.5 Torr
Power	75–100 Watts for 10"x18" chamber
Pumping	About 23 CFM/reactor
Etch Rate	About 1500–2000Å/minute
Spacing	At least ¾ inch apart for 3-inch wafers, loading back-to-back

Diluted CF_4/O_2 Mixtures

Temperature	Preheat to 80–100°C
Gases	Freon 14 (24%), oxygen (1%), helium (75%) Freon 14 (24%), oxygen (1%), nitrogen (75%)
Pressure	0.7–1.5 Torr
Power	150–250 Watts for 10"x18" chamber
Pumping	About 23 CFM/chamber
Etch Rate	About 600–1200Å/minute
Spacing	At least ¾ inch apart for 3-inch wafers, loading back-to-back

SiF_4/O_2 Mixtures

Temperature	Preheat to 80–120°C if using tunnel, no preheat without tunnel
Gas	SiF_4 (96%), oxygen (4%)
Pressure	0.8–1.2 Torr if using tunnel, 0.0–0.8 Torr without tunnel
Power	250–300 Watts
Pumping	23–35 CFM/chamber
Etch Rate	About 300–500Å/minute using tunnel, About 500–1000Å/minute without tunnel
Spacing	At least ¾ inch apart for 3-inch wafers, loading back-to-back

Process Control

Because polycrystalline silicon is so sensitive to etching plasmas, it can be processed most successfully under the close control provided by the Dionex 2000T. 8000T and the 9000 etcher/strippers. These are temperature-controlled plasma systems: they use a preheating step to make certain that all wafers, in all runs, have the same temperature and thermal history when etching begins. Information about these systems appear in *Product Bulletins 2000T/79, 8000T/79 and 9000/79.*

Special Considerations

Protecting Backs of Wafers

During any process for etching silicon wafers, the plasma must be restrained from attacking the backs of the wafers. There are two reasons for this. First, rapid etching of the wafer backs will heat the wafers, making process-control difficult. Secondly, the backs of the wafers will absorb large numbers of reagent particles. This will retard, in an uncontrollable way, the etching of the front surfaces of the wafers

Four methods are available for protecting wafer backs: oxidizing, coating with photoresist, shielding with aluminum plates, or arranging the wafers so that they stand back-to-back during etching.

BRANSON/IPC
a Smithkline company

Gas Plasma Systems
31159 San Benito Street, P.O. Box 4136, Hayward, CA 94544
(415) 489-3030, Telex: 337-759

BRANSON INTERNATIONAL PLASMA CORPORATION
1172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4138, Hayward, CA 94544 • (415) 489-3030

De-Scumming Wafers with Plasma

De-scumming removes photoresist residue (scum) from exposed parts of a workpiece, before the workpiece is etched. Typical residues are less than 0.1 micron (1000 angstroms) thick. A plasma usually can remove such residues in less than 1 minute.

De-scumming is most effective and least expensive when it is a part of the etching process. Wafers are loaded into the plasma reactor and de-scummed in an oxygen plasma. Then the oxygen is turned off automatically, and the etching plasma is established. This automatic, sequential processing eliminates handling and contamination of the wafers between the de-scumming and etching steps.

Operating Parameters

Here are typical parameters for de-scumming 50 3-inch wafers in an 8-inch plasma reactor, during a sequential process that includes de-scumming and etching. The wafers are inside a Dionex Etch-Tunnel cylinder.* The cylinder isn't needed during de-scumming: de-scumming times are so short that the wafers can't become overheated. But it usually is convenient to have the wafers in a cylinder during de-scumming, so that they can be etched as soon as de-scumming is completed. This tactic obviously must be used when wafers are de-scummed and etched by an automated sequential process.

Reagent gas
Industrial-grade oxygen

Temperature
100°C

RF power
150 watts

Oxygen flow-rate
100 milliliters/minute

Reactor pressure
0.6 Torr

Vacuum pumping
500 liters minute (17 cu. ft./minute) from each reactor

Time
about 1 minute

Process Control

De-scumming must be controlled very closely. If the process lasts too long, the oxygen plasma can alter photoresist patterns—especially in regions near the edges of the wafers. This can seriously reduce across-wafer uniformity.

Generally, it is advantageous to preheat wafers before de-scumming them. This can be done best by an inert-gas plasma; nitrogen is the gas used most often. The wafers are loaded into the reactor and the nitrogen plasma is turned on. When the wafers reach the desired de-scumming temperature, the nitrogen plasma is extinguished automatically and an oxygen plasma is established; this plasma de-scums the wafers for a selected period of time.

By ensuring that all of the wafers—in all runs—are at the same temperature when de-scumming begins, this preheating makes de-scumming a highly reproducible, controllable process.

Preheating always is necessary during the de-scumming of wafers and photoplates that carry dense, sub-micron patterns formed by electron-beam methods.

When preheating is used, de-scumming becomes a two-step process. Such a process can be performed automatically and reliably in the Dionex 8000T etcher/strippers. These machines were designed specifically for two-step processes that include preheating with an inert-gas plasma.

Two-step de-scumming can be combined with etching in an automatic three-step process, using Dionex 2000T etcher/strippers.

The Dionex 9000, the most advanced barrel plasma system available, is capable of storing sixteen complete and separate programs, each with up to sixteen individual steps. De-scumming can easily become an automatic step in any or all of these programs.

All Dionex etcher/strippers have control units that govern all process parameters during each step in a sequential process.

***The Etch-Tunnel cylinder is a proprietary Dionex product for improving plasma-etching processes. It is a perforated metal cylinder that protects wafers from ions and radiation created within the etching plasma. This enhances greatly the across-wafer and wafer-to-wafer uniformity of the etched wafers. The cylinder is described fully in *Product Bulletin 7501*.**

BRANSON/IPC
a SmithKline company

BRANSON INTERNATIONAL PLASMA CORPORATION
31172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

Stripping Wafers with Plasma

Plasma-stripping is a safe, fast and clean technique for removing positive or negative photoresist from wafers, chromium photoplates and other microelectronic workpieces that have been etched. Typical photoresist layers are about 1 micron thick, but plasma-stripping can remove layers as thick as 25 microns without difficulty.

Under production conditions, photoresist layers about 1 micron thick can be stripped in 15 to 40 minutes. Even very thick dry-film resists can be stripped in 30 to 40 minutes, using an oxygen/Freon plasma.

Several different stripping processes are used commercially. The most important are:

Stripping with oxygen: In this process, stripping is performed by a highly reactive oxidizing plasma. The plasma is created by ionizing industrial-grade oxygen. Oxygen plasmas are used for stripping photoresist from substrates that are relatively insensitive to oxidation. These substrates include silicon, silicon compounds, titanium, tungsten, tin and indium oxide.

Stripping with oxygen and Freon: Some photoresist layers are unusually thick or difficult to oxidize. Such layers can be stripped with oxygen, but the process is slow. They can be stripped more rapidly in a plasma formed from a mixture of oxygen and a fluorinated gas, such as Freon 14 (CF_4). Oxygen/Freon plasmas must be used carefully, because fluorine-bearing free radicals in the plasma can damage certain substrates, such as silicon nitride.

Stripping with wet air: In this process, the stripping plasma is formed by ionizing wet air—air that has been bubbled through water, so that it is saturated with moisture when it reaches the plasma reactor. A wet-air plasma is a much milder oxidizing agent than is an oxygen plasma or an oxygen/Freon plasma. Wet-air plasmas are used to strip substrates that would be damaged by the stronger plasmas. These substrates include chromium, gold and nichrome. Wet-air stripping is used widely in the production of chromium photoplates.

The remainder of this bulletin presents details about these three stripping processes.

Stripping with Oxygen

Operating Parameters

Here are typical values for process variables when wafers are stripped in an oxygen plasma.

RF power
500 watts for 8"x18" reactor
700 watts or more for 10"x18" reactor

Vacuum pumping
500 liters/minute (17 cu. ft./minute) for 8"x18" reactor
675 liters/minute (23 cu. ft./minute) for 10"x18" reactor

Reactor pressure
1 to 2 Torr in 8-inch reactor
1 to 2 Torr in 10-inch reactor

Oxygen flow-rate
Depends on reactor pressure:
300 milliliters/minute for 1 Torr
800 milliliters/minute for 2 Torr

Reactor temperature
100°C is the minimum for a commercial process. Generally, temperature needn't be closely controlled. It will rise as stripping progresses, and might reach 200° to 250°C by the end of the run.

Time
Under the conditions given here, a 1-micron layer of positive photoresist can be stripped from 100 2-inch wafers in about 20 minutes.

For 100 3-inch wafers under the same conditions, the time is about 35 minutes.

Process Refinements

The speed and effectiveness of a stripping process can be improved substantially by two tactics:

- Preheating the wafers
- Dividing the stripping process into multiple steps, using different combinations of RF power and oxygen flow-rate.

Advantage of Preheating Wafers

Stripping is accelerated significantly if the wafers are heated before stripping begins. Boats full of wafers can be heated in an oven before they are placed into the reactor. Or reactors can be equipped with infrared lamps that will heat the wafers to 200°–300°C as soon as the stripping plasma is established in the reactor, and will maintain this wafer temperature throughout the process. Such lamps, which can reduce stripping time by as much as 50%, are available as optional equipment on all Dionex etcher/strippers.

Advantage of Multiple-Step Stripping

In principle, an increase in the flow-rate of oxygen to the plasma reactor should accelerate the stripping process. This certainly happens when a few wafers, widely spaced in the reactor, are stripped under experimental conditions. But in production situations, when the reactor holds 100 to 200 closely spaced wafers, a high flow-rate may retard effective stripping.

Here is the explanation for this. As the oxygen flow-rate increases, the pressure inside the reactor increases proportionally. The higher pressure inhibits the movement of reactive plasma particles in the spaces between wafers. The edges of the wafers will be stripped more rapidly, but the centers of the wafers will be stripped slowly and poorly.

Dionex has developed a technique for exploiting the advantages of a high oxygen flow-rate while avoiding its drawbacks. The stripping cycle is divided into two or three steps. In the first step, a high flow-rate and strong RF power are used for rapidly stripping the edges of the wafers. Then the flow-rate and the RF power are reduced, so that the centers of the wafers can be stripped quickly and thoroughly. Such a process can be significantly faster than one that uses a constant flow-rate and constant RF power.

Example: 100 3-inch wafers, spaced $^3/_{16}$ inch apart, were stripped in an 8-inch reactor. Each wafer carried a 1.5-micron layer of positive photoresist. With the optimal combination of oxygen pressure and RF power (2.0 Torr, 450 watts), stripping time was 34 minutes.

An identical batch of wafers was stripped by a two-step process: 15 minutes at 2.0 Torr and 450 watts; then 7 minutes at 0.5 Torr and 150 watts. This 22-minute process (15 minutes + 7 minutes) was just as effective as the 34-minute process that used a constant flow-rate and constant RF power.

The advantages of multiple-step stripping increase as the diameter of the wafers increases. In the conservative example given above, the time required to strip 3-inch wafers was reduced by about 35%. When 4-inch or 5-inch wafers must be stripped, a multiple-step process can reduce stripping time by 50% or more.

Process Control

All Dionex etcher/strippers have automatic control units that govern the oxygen flow-rate, RF power, reactor pressure and processing time. Series 4000 etcher/strippers can execute single-step processes only. Series 8000 machines are designed for two-step processes, and Series 2000 for three-step processes. The Dionex 9000 is the newest and most advanced of the barrel plasma systems. It can store sixteen separate programs, each with up to sixteen individual steps.

Advanced Automation: DPS-1000

All Dionex etcher/strippers can be equipped with the DPS-1000 stripping-controller. This is a proprietary Dionex device that monitors the progress of stripping reactions, and automatically stops the process when all of the wafers have been stripped completely. Here is how it works:

During stripping, photoresist is oxidized to gaseous reaction products, including hydrogen compounds. These products are converted to plasma, and the hydrogen in this plasma emits light at about 6560 angstroms. DPS-1000 measures the concentration of reaction products in the reactor by measuring the intensity of this light. When the intensity reaches a stable minimum, stripping is complete. DPS-1000 then turns off the plasma and sounds an alarm.

DPS-1000 brings unprecedented accuracy and economy to stripping operations. It automatically and precisely accommodates run-to-run variation in the number of wafers being stripped; and in the amount of photoresist on each wafer; and it reduces process time to an absolute minimum.

During each run, DPS-1000 prints a curve that shows how the intensity of light from the pertinent reaction products changes with time. Figure 1 shows a representative curve. When stripping begins, the optical signal quickly rises to a maximum. As photoresist is removed from the wafers, the intensity falls. After about 10.5 minutes of stripping (in the process depicted here), it has stabilized at a minimum, positive value that represents background light from the stripping plasma. DPS-1000 then turns the stripping plasma off, and light intensity falls to zero.

DPS-1000 is so precise that it can monitor the stripping of a single wafer, or of batches as large as 300 wafers.

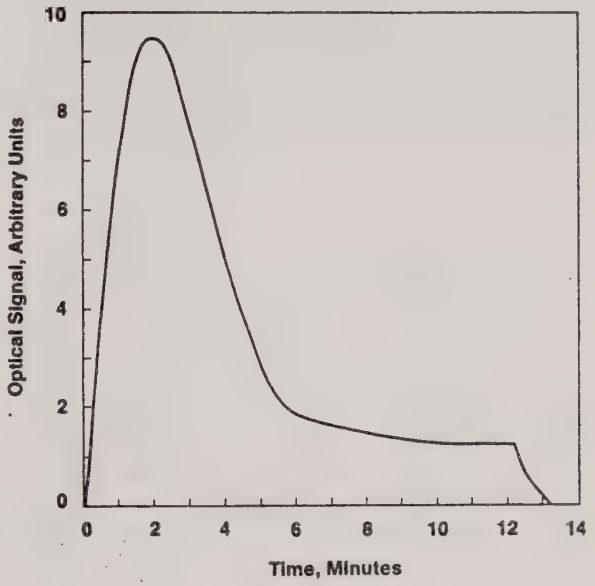


Figure 1

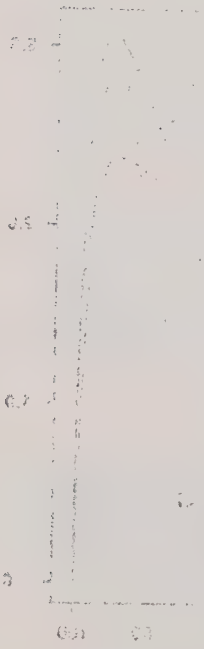
Concentration of oxidation products in a reactor during a stripping process. This figure is a redrawing of a record produced by a DPS-1000 stripping-controller. The ordinate shows the intensity of light (at about 6560 angstroms) from hydrogen atoms in the oxidation products.

Stripping in the Etch-Tunnel

The Etch-Tunnel cylinder is a proprietary Dionex product that is used widely in plasma-etching processes. It is a perforated metal cylinder that protects workpieces from ions and radiation created by the etching plasma. It thus prevents local overheating of the workpieces, and enhances across-wafer and wafer-to-wafer uniformity. The cylinder is described fully in *Product Bulletin 7501*.

The Etch-Tunnel cylinder retards stripping. Wafers usually are removed from the cylinder before they are stripped. But in some cases, it is desirable to leave the wafers inside the cylinder during stripping. There are two reasons for doing this:

Vulnerable workpieces: During the stripping of very sensitive workpieces, the cylinder shields the workpieces from ions and radiation associated with the stripping plasma. In other words: the cylinder performs the same function during stripping that is performed during etching.



Convenience: If workpieces have been housed in an Etch-Tunnel cylinder during etching, it will be convenient to leave them in the cylinder during stripping—even if the workpieces could tolerate exposure to ions and radiation. This eliminates the need to open the reactor or handle the workpieces before stripping them.

Stripping Vulnerable Workpieces

Here are typical values for process variables when vulnerable workpieces are stripped inside an Etch-Tunnel cylinder. Under these conditions, no plasma will exist inside the cylinder, and no ions or radiation will reach the workpieces.

RF power
200 to 300 watts for 8-inch reactor

Vacuum pumping
500 liters/minute (17 cu. ft./minute) from each reactor

Reactor pressure
1.5 Torr, minimum

Oxygen flow-rate
650 milliliters/minute

Time
Stripping a 1-micron layer of photoresist from 50 3-inch wafers, in an 8-inch reactor, takes about 30 minutes. (Without the Etch-Tunnel cylinder, the same stripping could be performed in 12 to 15 minutes.)

Stripping Tolerant Workpieces

Here are typical operating parameters for stripping, in an Etch-Tunnel cylinder, workpieces that can tolerate exposure to ions and radiation generated by the stripping plasma. Under these conditions, some plasma will exist inside the cylinder.

RF power
400 to 500 watts for 8-inch reactor

Vacuum pumping
500 liters/minute (17 cu. ft./minute) for 8"x18" reactor
675 liters/minute (23 cu. ft./minute) for 10"x18" reactor

Reactor pressure
0.5 to 0.7 Torr

Oxygen flow-rate
100 milliliters/minute

Time
Under these conditions, stripping a 1-micron layer of photoresist from 50 3-inch wafers takes about 20 minutes.

Stripping with Oxygen and Freon

Applications

A plasma made from a mixture of oxygen and Freon 14 (CF_4) can oxidize photoresist more quickly than a pure-oxygen plasma can. The time required for stripping typical photoresists with oxygen/Freon is less than 50% of the time needed for stripping the same photoresists with oxygen alone.

Oxygen/Freon stripping is used most often for:

- Stripping very thick photoresist layers—e.g., dry-film photoresists as thick as 25 microns.

- Removing photoresist that has been toughened by long exposure to etching plasmas that contain halogens—e.g., fluorine-bearing plasmas, and the chlorinated plasma that is used in the Dionex DryAl process for etching aluminum. These plasmas can toughen photoresist by cross-linking and halogenating its surface.

Oxygen/Freon stripping plasmas must be used carefully, because they attack exposed substrates, such as silicon and its compounds. This hazard can be minimized by choosing an appropriate ratio of Freon to oxygen. Figure 2 shows how the etching rates of silicon, SiO_2 and Si_3N_4 depend on the percentage of Freon in the reagent gas mixture. When the percentage is 30% or less, etching rates are so low that they are negligible for most practical purposes. A mixture containing 30% Freon is used widely in commercial stripping processes.

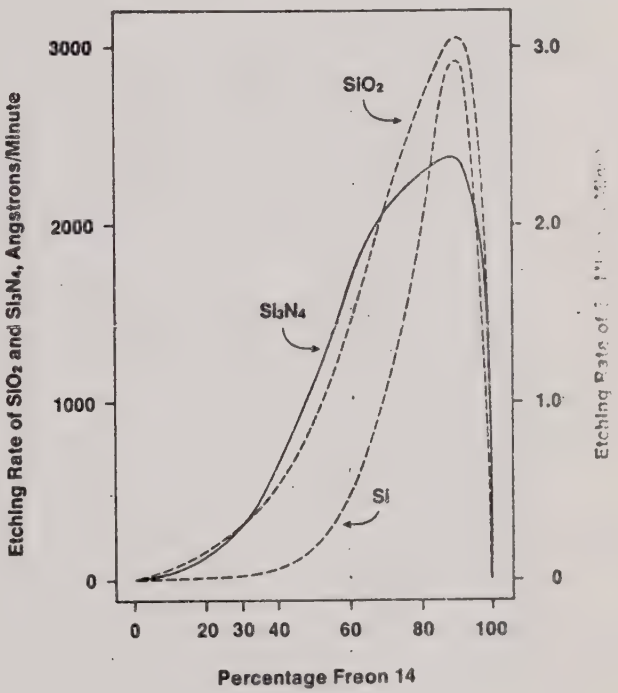


Figure 2
Etching rates of silicon and silicon compounds in plasmas formed from different mixtures of oxygen and Freon 14 (CF_4). Reactor pressure is 1.0 Torr, and RF power is 300 watts. The materials tested aren't etched vigorously if the Freon percentage is 30% or less. *These curves are based on experiments by S. Iwamatsu and K. Hirobe of Hitachi, Ltd.*

Process Refinements and Control

All of the process-refinement and process-control information given under *Stripping with Oxygen* applies to stripping with oxygen and Freon.

Stripping in the Etch-Tunnel Cylinder

The role of the Etch-Tunnel cylinder in stripping was described above, under *Stripping with Oxygen*. When workpieces are stripped inside a cylinder, the advantages of using an oxygen/Freon mixture are especially dramatic. In typical cases, the time required for stripping photoresist with an oxygen/Freon plasma is about 25% of the time needed for stripping the same photoresist with oxygen alone.

Stripping with Wet Air

Operating Parameters

The suggestions given here apply to the processing of chromium photoplates. These are the substrates most often stripped in wet-air plasmas. For suggestions about the stripping of gold, nichrome or less common substrates, please contact the Dionex headquarters in Hayward, California.

Here are typical values for process variables when photoplates are stripped in a wet-air plasma.

RF power
500 to 600 watts for 10-inch reactor
650 to 750 watts for 12-inch reactor

Vacuum pumping
500 liters/minute (17 cu. ft./minute) for 8"x18" reactor
675 liters/minute (23 cu. ft./minute) for 10"x18" reactor
880 liters/minute (30 cu. ft./minute) for 12"x18" reactor

Reactor pressure
1 to 2 Torr in 10-inch reactor
1 to 2 Torr in 12-inch reactor

Wet-air flow-rate
1000 milliliters/minute

Reactor temperature
Chromium photoplates—and most of the other substrates that require wet-air plasmas—cannot tolerate strong heating. The substrate temperature should be held between 80° and 100°C during the entire process. Overheating can cause two problems: chemical degradation of the substrate, and loss of substrate material by oxidation and vaporization.

Time
In a reactor 20 inches long and 12 inches in diameter, loaded with 10 square 4-inch chromium photoplates, the time required to remove a 1-micron layer of positive photoresist is about 15 minutes. Stripping time is minimized when the photoplates stand parallel to the long axis of the reactor.

Process Control

All Dionex etcher/strippers can execute wet-air stripping processes in which RF power, reactor pressure, wet-air flow-rate and stripping time are controlled automatically. Series 4000 etcher/strippers can perform one-step processes only. Series 8000 machines are designed for two-step processes, and Series 2000 for three-step processes. The advanced, fully programmable, Dionex 9000 is capable of storing up to sixteen complete programs, each with up to sixteen individual steps.

The Dionex DPS-1000 stripping-controller, described earlier in this bulletin, *cannot* be used during wet-air stripping.

BRANSON/IPC
a SmithKline company
Gas Plasma Systems
31159 San Benito Street, P.O. Box 4136, Hayward, CA 94544
(415) 489-3030, Telex: 337-759

RANSON INTERNATIONAL PLASMA CORPORATION
172 Huntwood Avenue, P.O. Box 4136, Hayward, CA 94544 • (415) 489-3030

www.manualsplus.com
1019005